APR 28 1932

MAINTENANCE ENGINEERING

In Plants, Mills, and Factories

TO THE maintenance engineer in the plant where maintenance is being neglected, warning! Haywire policies now mean trouble later.

Who will hold the bag? Most likely you, Mr. Maintenance Engineer. If you have taken "spend-not" orders sitting down, watch out.

Marshal the facts. Get the figures. Put them on paper. Present them to your executives. Keep a copy.

When post mortem time arrives, you'll be sitting pretty.

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MAY
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RIGID TEST

The shop testing to which Allis-Chalmers Centrifugal Pumps are subjected is insurance to buyers that these pumps will give the performance guaranteed. Testing facilities at Allis-Chalmers permit testing comparatively large size pumps as this 42″ x 36″, 42,000 g.p.m. at 20 ft. head, pump illustrates. This facilitates the obtaining of engineering data for continually improving designs. The purchaser of an Allis-Chalmers Centrifugal Pump, therefore, gets the double benefit of tested pumps that embody the latest and best features in design.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

ALLIS-CHALMERS

MAINTENANCE ENGINEERING

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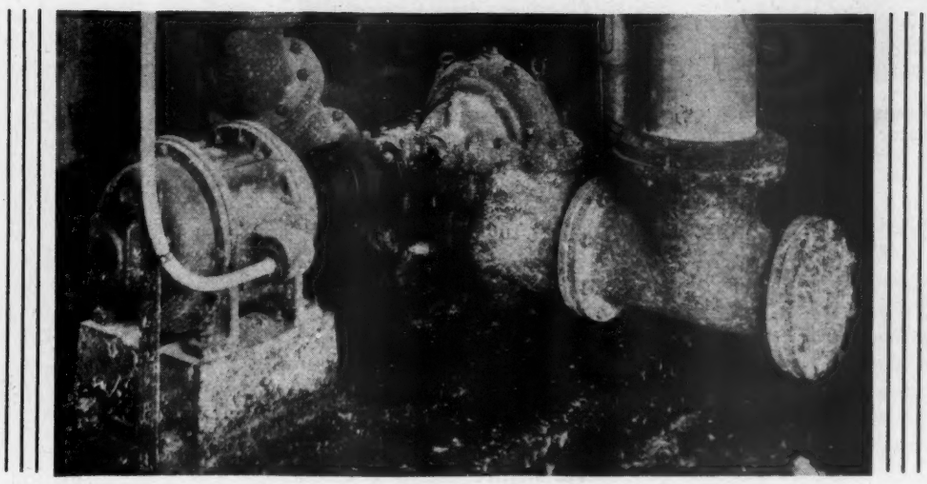

Insulation—Antidote for Shutdowns

E. C. DIEFFENBACH

Industrial Engineering Department
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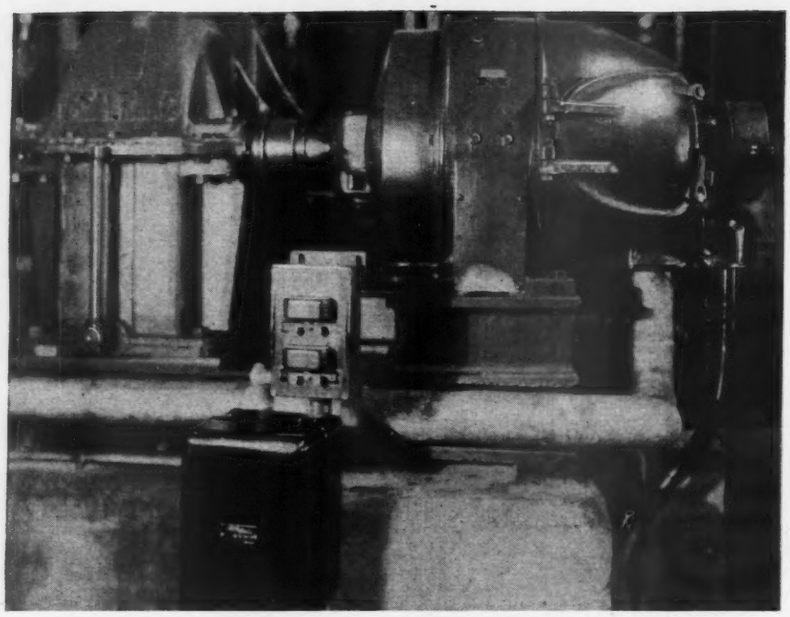
ELECTRICAL manufacturers draw upon a wide range of materials for insulation. They consider electrical, physical, and chemical properties, studying such characteristics as strength, hardness, heat conductivity, thermal expansion, change of resistance on heating, softening by heat, and effect of one material on the other when they are compounded. These properties are determined and recorded by an elaborate series of tests both on the raw materials entering into the manufacture of insulation and on the insulation in its finished state.

A brief mention of insulation requirements in industry illustrates how widely diversified the uses of these materials are. Wearing under abrasion is necessary in commutator insulation and undesirable in dead segments of controllers; heat conductivity is desirable in coil insulation of motors and generators but not in the insulation of the heating elements of electric ovens. Liquids are widely used to supplement solid insulation in transformers and are also as a vehicle in the many insulating paints and varnishes.

The A.I.E.E. and other national societies have selected temperature limits as the standard for the insulation of electrical rotating apparatus and regard this as the chief factor affecting the life of insulation. Four major classifications are made in the A.I.E.E. Standards as follows:

1—Class *O* insulation consists of cotton, silk, paper, and similar organic compounds, when neither impregnated or immersed in oil.

2—Class *A* insulation consists of cotton, silk, paper, and similar organic materials when impregnated or immersed in oil; also enamel as



Direct-current, inclosed, externally-ventilated motor with speed regulator driving a press of board machine. Total inclosure provides protection against entrance of moisture to windings.

ordinarily applied to conductors.

3—Class *B* insulation consists of inorganic materials such as mica or asbestos in built-up form combined with binding substances. If Class *A* material is used in small quantities with Class *B*, for structural purposes only, the combined material may be classed as Class *B*, provided the electrical and mechanical properties of the insulated winding are not impaired by the application of the temperature permitted for Class *B* material.

In the insulation of electrical rotating apparatus for use in wet places, the above A.I.E.E. designations must be adhered to, and in addition steps must be taken to prevent the entrance of moisture into the insulation. Electrical manufacturers can do much toward the exclusion of moisture if they are advised of the conditions under which the machine is to operate.

Two conditions often met with in industry are (1) steam, excessive moisture from vapor, splashing, dripping, or flooding (pulp and paper mills, packing plants, bleacheries) and (2) excessive amounts of acid or alkali vapors, fumes, or dusts (chemical and fertilizer plants, paper mills).

In the first condition the motor may be located where steam and moisture cannot be avoided; perhaps it will be a boiler feed water pump drive or a beater drive in a paper mill. The motor should be located well above the flood stage so that water cannot run into the windings. A drop cover or inclosure is advisable when water drips from the ceiling or splashes in from the side. If the motor is constructed to operate with a total inclosure, so much the better. However, the manufacturer should be advised of the conditions so that moisture resisting insulation can be supplied and a proper voltage recommended.

In the second condition the same precautions should be observed. The manufacturer can supply windings impregnated with special varnishes so that a seal is maintained against the entrance of solutions laden with acids or alkalies into the interstices of the fabric. If this is not done the acids or alkalies attack the fibers in the fabric itself, weaken it, and produce leakage paths to ground. As before, direct contact with liquids does not represent the best practice and the use of voltages as low as practicable is recommended to keep down insulation and frame size.

As a rule, adverse conditions of ambient temperature or of conductive or abrasive dusts are not found where conditions 1 and 2 are encountered. If they are, the manufacturer must be advised so that he can supply special insulations resistant to these conditions. He cannot provide absolute protection against all insulation difficulties but he can give the motor an operating life approaching more nearly the performance of a motor under normal conditions.

If the motor is accidentally flooded or if the windings are damp from prolonged disuse steps should be taken for drying before the motor is placed into operation again. A small motor can be removed and placed directly into an oven, provided the temperature is kept down to a point where the insulation will not be damaged. A temperature of 90 deg. C. is a safe value for Class *A* insulation. Sufficient time should be taken for drying before insulation resistance

CLASSIFICATION OF INSULATION MATERIALS BY RAW PRODUCTS

1—Fibrous (organic)
- **a—Papers**
- **b—Fabrics**
- **c—Woods**

2—Fibrous (inorganic)
- **a—Asbestos**

3—Mica
4—Ceramics
5—Slate, Marble, and Soapstone
6—Bitumens
7—Oils
8—Resins and Gum
9—Oxides

AIDS TO INSULATION

1—Molded compounds
2—Solvents
3—Varnishes
4—Cements, bonds and adhesives
5—Clays, silicates, etc.
6—Portland cement

METHODS OF PRODUCTION

1—Insulation produced in quantity for cutting or machining to shape.
- **a—Rolls, sheets, slabs, tubes, rods.**

2—Insulation produced in individual pieces.
- **a—Molded parts, porcelain, and other ceramic parts.**

3—Insulation prepared in liquid form and used as liquids or solids.
- **a—Oils, varnishes, synthetic resins, cements.**

4—Insulation built in place.
- **a—Fabric windings, impregnated.**
- **b—Varnish dipping and baking.**
- **c—Built-up insulation in laminations of one or many materials.**

tests are taken. If the motor is too large for removal, a low current can be passed through the windings, or heat can be introduced by a blower or fan after inclosing the motor with a canvas covering. When heat is applied in this manner care should be taken to provide an opening in the cover for the escape of moisture.

Control Insulation

The protection of control apparatus located in wet places presents different problems from those pertaining to rotating electrical apparatus. The protection of control is favored by two advantages — total inclosure, and location.

Total inclosure permits the use of tight gasketed covers with the contacting mechanisms either oil- or air-immersed. Such construction is resistant to moisture, the degree of effectiveness governed by the care given to the fits, i.e., where movable parts such as pushbuttons and switch handles project through the case.

Control equipment permits some choice as to location. It can be placed on a wall or pedestal away from dripping ceilings and splashings from the floor. The life of the exposed parts is prolonged if they are plated with cadmium, tin, or other corrosion resisting material.

Special factory finishes include lacquers, varnishes, and paints. They are applied to springs, auxiliary switches, and interlocks; finishes having insulating properties are applied in some instances. Impregnation of coils by moisture resisting varnishes is good manufacturing practice. Corrosion resisting paints are used on covers, standards, channels and supports.

On installation if there is any choice as to location, dripping water and moisture laden fumes should be avoided if possible. Open windows and steam or water pipes also should be avoided. The operator at all times can keep the gaskets in good order and see that inclosures are properly in place by systematized inspections; he also can renew the finish on parts by applying the approved factory varnishes and paints.

Costly shutdowns caused by burned out motor windings, short circuits, and creepage paths leading up to insulation failure will be reduced if precautions are taken during and after installation.

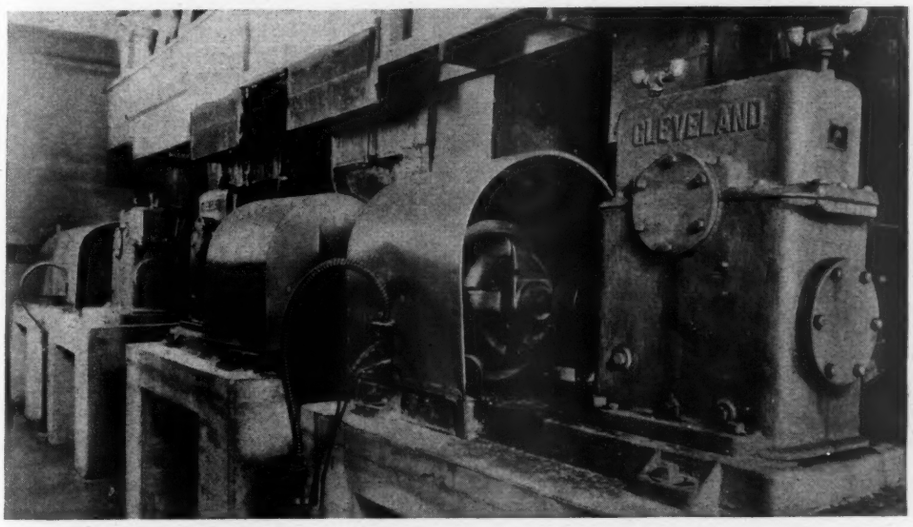
Switchgear Insulation

Switchgear, like control, has some advantage as to location. It should be placed in a room where a minimum of moisture and fumes is encountered. The surface of the board and attached apparatus tends to condense the moisture, causing corrosion, grounds, and short circuits. Close proximity to piping where dripping water may collect is not good switchgear practice.

Factory finishes for moisture laden atmospheres include special finishes for relays, rheostat mechanisms, undervoltage devices, magnetic locks, circuit breakers, and the like. They are corrosion resisting and by keeping the mechanical parts protected, the insulation around conductors and between adjacent parts is protected from the penetration of moisture and from a chance semi-conducting film which might form a creepage path. The factory also can supply panels resistant to moisture and fitted with bushings when there is danger of leakage. Coil impregnation with special moisture resistant compounds is another aid toward the exclusion of moisture from those parts.

As mentioned under control, these special finishes can be supplied if the factory is advised of the conditions under which the switchgear is to operate. After installation the operator can assist materially in maintenance program by periodic inspection and by the use of good paints, varnishes, and protective coatings on exposed parts; the original finish can be protected and corrosion reduced to a minimum by applying them regularly. Such parts as channel sills, pipe supports, fittings, outsides of tanks, transformers, and inclosing cases are not only improved in appearance, but preserved for long life. Protection of buses and connections by means of vaseline or lacquer is of considerable assistance in the prevention of the corrosion of the copper. Care should be taken, however, to keep all such preparations away from contacting surfaces and out of the bearings of moving parts of equipment.

An extremely important part of power transmission, distribution, and interconnection of apparatus is the insulation of the conductors. The ability of moisture to absorb so many harmful compounds, and its tendency



Four electric motors driving a bank of flat screens in the screen room of a paper mill. Note the drip covers of sheet iron, built over the motors for protection againt dripping and splashing. The motors are of the open horizontal type.

when so laden to act as a conductor, make it one of the most important things to be guarded against in cable insulation.

In the interests of economy the cross-sectional area of a conductor is kept down to the lowest value at which the cable will carry the required current. The insulation then, is concerned with the temperature on overload. Such an increase in temperature causes expansion and contraction of the cable and gives rise to stresses in the sections between the joints and in the joints themselves. Insulation, therefore, must withstand temperature rises and the physical stresses induced by them, and it also must keep out moisture. Good joints are extremely important, for they are the most vulnerable parts in the entire installation.

Cable insulation includes solid paper, oil-filled paper, varnished cambric, and rubber—of many types and in many combinations. These are assisted by a variety of fillers, tapes, braids, and armors.

Lead sheathed paper for cable, both solid and oil-filled, is common in transmission work and is excellent for wet locations if the joints are carefully made. This is the most difficult kind of cable to install because of the mechanical difficulties encountered, and because of the care which must be taken to seal all joints to prevent the entrance of moisture. Specified radii at the bends must not be exceeded.

Rubber covered cable is sometimes employed for transmission work where peak load temperatures will not be exceeded. It is flexible but ages more quickly than lead-sheathed paper covered cable, and will not carry high voltages as safely.

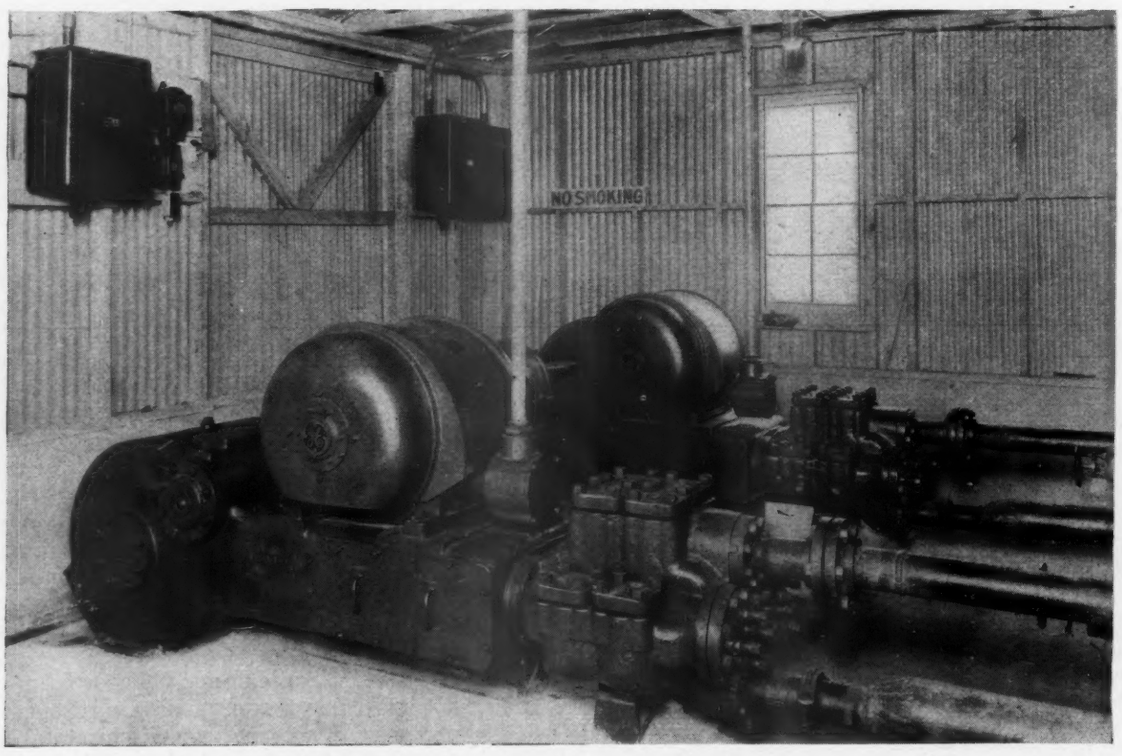
For power distribution, lead sheathed paper, rubber, and varnished cambric covered cables are the best known moisture resisting types. Plant conditions govern the selection. Lead sheathed, paper covered cable is favored for primary distribution because of its ability to operate at the heavier loads and higher voltages. Rubber covered cable is favored for secondary distribution on account of its flexibility and waterproof qualities. Varnished cambric covered cable is also employed and is generally lead sheathed.

The flexibility and waterproof qualities of rubber covered cable make it excellent for interconnecting apparatus. For the higher voltages varnished cambric and paper insulated cable are preferred for their longer life. Paper insulated cable is especially favored where heavy load currents occur.

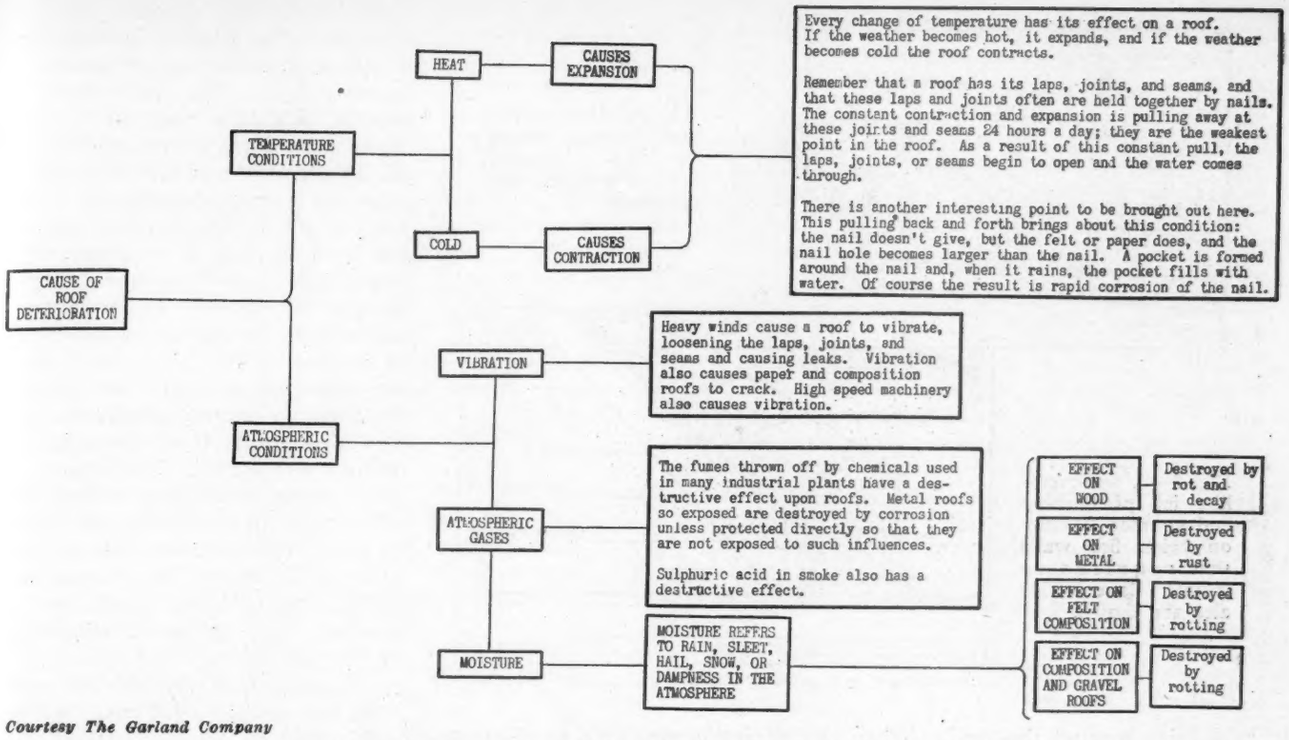
Absence of moving parts, and the fact that they are usually totally inclosed, suit transformers to applications in wet places. Types thoroughly protected by moisture proof inclosing cases and gasketed covers have been developed for use in outside as well as indoor locations.

Insulating materials used in the manufacture of transformers present greater problems than the conducting, magnetic, or structural materials because little useful data are available and the characteristics of these materials are difficult to predict. Both solids and liquids are employed in a great variety of compounds and fillers. Solids are used as strand insulation, separators, and carriers, and liquids in the intervening spaces as assistance to the solid insulation.

When a transformer is first placed in service care should be taken to see that the oil is sufficiently dry for service. While a transformer is in shipment, surrounding conditions do not stimulate actual service and moisture may enter the inclosing case. This is especially true when transformers are shipped without oil in the tank; humidity in the air may enter the tank and be absorbed by the insulation. Various methods are specified by transformer manufacturers for drying transformer oil when tests show that the oil contains too much moisture for safe operation.



Splash-proof squirrel-cage, 50 hp., 1,200 r.p.m., 440 volt induction motors driving oil gathering pumps in an oil field. Control is by magnetic and disconnecting switches.


CAUSE OF ROOF DETERIORATION
TEMPERATURE CONDITIONS
HEAT
CAUSES EXPANSION
COLD
CAUSES CONTRACTION
Every change of temperature has its effect on a roof. If the weather becomes hot, it expands, and if the weather becomes cold the roof contracts.
Remember that a roof has its laps, joints, and seams, and that these laps and joints often are held together by nails. The constant contraction and expansion is pulling away at these joints and seams 24 hours a day; they are the weakest point in the roof. As a result of this constant pull, the laps, joints, or seams begin to open and the water comes through.
There is another interesting point to be brought out here. This pulling back and forth brings about this condition: the nail doesn't give, but the felt or paper does, and the nail hole becomes larger than the nail. A pocket is formed around the nail and, when it rains, the pocket fills with water. Of course the result is rapid corrosion of the nail.
ATMOSPHERIC CONDITIONS
VIBRATION
Heavy winds cause a roof to vibrate, loosening the laps, joints, and seams and causing leaks. Vibration also causes paper and composition roofs to crack. High speed machinery also causes vibration.
ATMOSPHERIC GASES
The fumes thrown off by chemicals used in many industrial plants have a destructive effect upon roofs. Metal roofs so exposed are destroyed by corrosion unless protected directly so that they are not exposed to such influences.
Sulphuric acid in smoke also has a destructive effect.
MOISTURE
MOISTURE REFERS TO RAIN, SLEET, HAIL, SNOW, OR DAMPNESS IN THE ATMOSPHERE
EFFECT ON WOOD
Destroyed by rot and decay
EFFECT ON METAL
Destroyed by rust
EFFECT ON FELT COMPOSITION
Destroyed by rotting
EFFECT ON COMPOSITION AND GRAVEL ROOFS
Destroyed by rotting

Courtesy The Garland Company

Fig. 1—Common causes of roof deterioration and how they act.

Industrial Roof Maintenance

H. L. SCHULTZ

Assistant Superintendent of Maintenance
The Carborundum Company, Niagara Falls, N. Y.

IN THE well established industrial plant comprised of several or more buildings the problem of obtaining effective roof maintenance is ever present. Too often this problem is not given the consideration and attention due it in comparison with others of smaller importance and annual cost. False economy often is practiced to such an extent that the spoilage of material in process and the damage to buildings and equipment that frequently result from defective roofs more than offset the small additional cost required to insure against such conditions.

Types of Roofs—Following are the principal types of roofing in general use in industry:

(1) Built-up felt lap (including rolled-in-gravel, asphalt, or slate top)
(2) Built-up paper lap
(3) Slate and tile
(4) Corrugated steel sheeting (protected and unprotected)
(5) Corrugated and flat asbestos-composition sheeting
(6) Miscellaneous solid mopped

In addition there are several other types of roofs for special applications, most of which are a modification or combination of those listed. However, types most commonly used on existing buildings, especially structures of long standing, will come under Nos. 1, 2, 4, or 6. This article, therefore, is confined mainly to this group with the purpose of outlining methods for minimizing the maintenance cost of such roofs.

Causes of Roof Troubles—It will not be amiss here to emphasize some of the causes for roof troubles and deterioration. Because many of these troubles are avoidable, unnecessarily high maintenance costs result from neglecting to take steps necessary for their elimination. In many plants common abuses of roofs that could be eliminated easily either are looked upon with indifference or passed over entirely.

When roofs are used for short cuts or runways without employing protective features for the covering they are mighty costly thoroughfares. In most instances a simple raised plank platform or gangway will eliminate the necessity for a premature re-roofing job. Workmen frequently leave nails, bolts, and miscellaneous sup-

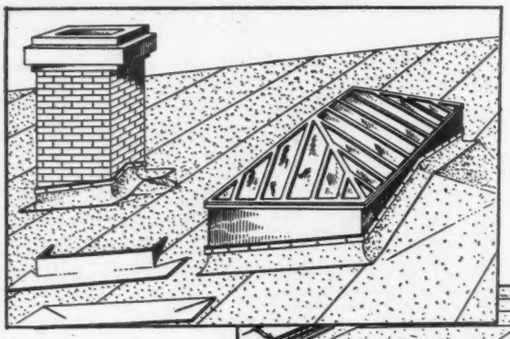


Fig. 2—How saddles and flashing should be constructed around skylights and chimneys.

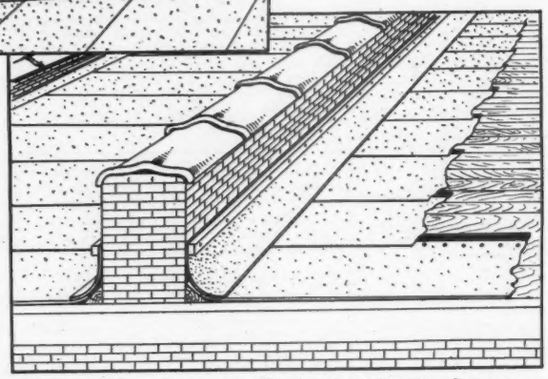


Fig. 3—A workmanlike job of flashing and counter flashing on brick fire walls that requires no metal. Cant strips also are shown.

Illustrated 2 to 5 courtesy The National Roofing Company

plies lying around the roof. When such items are stepped on they penetrate the deck, causing sure leakage within a short period of time. Dirt and moisture, if allowed to accumulate in valleys and gutters, soon will cause wet rot and deterioration in the best of roofing. Improper anchorage of guy wires, stacks, and so on are sure to leave their telltales in leakage and damage to under-roofing. The chart shown in Fig. 1 gives a comprehensive outline of the causes of roof deterioration. Although many of these causes cannot be eliminated they can be combated satisfactorily by using the proper type of roofing and an adequate system of preventive inspection and repair.

Procedure and Method of Repair—Where a plant's roofs cover an unusually large area a maintenance roofing gang can be kept busy constantly. But in most plants it is not profitable for the maintenance crew to handle such jobs as building new roofs. This work usually involves the difficult tasks of constructing skylights, pents, flashings, and saddles. A satisfactory roofing job is the work of specialists.

When calling for outside bids on roofing it is of primary importance to be sure that all bids apply to work of equal quality and service. Few items present the possibilities of misrepresentation that may be found in a roofing job. Engineers guided by price alone are likely to be misled.

It is therefore necessary, in fairness to all concerned, that all bidders quote on the same rigid specifications. Where this procedure is not followed it will be found that many of the contractors are figuring on different weights and gages of roofing material and flashing—although all may give the same guaranty as regards the number of years' service. If it is known that a certain roof can be expected to last as long as its guaranty, roofs of like quality but of heavier materials should outlive this period.

An important feature involving mopped or composition roofs of an asphalt base is the difference between Trinidad and petroleum asphalts. The latter type is lower in cost and generally is figured upon unless the former type is called for in the specifications. Trinidad asphalt will give a far more serviceable roof because it is not as subject to cracking and orange peel effect, and it will withstand alternate expansion and contraction without ill effects.

Where conditions make it advisable for a plant's maintenance department to take care of all re-roofing jobs in addition to general roofing repairs certain simple but very important practices should be carried out.

Before re-roofing a building the deck should be spudded level making sure that no protruding or loose nails remain, likewise that no bubbles or pockets of the old roof are left behind. These precautions should apply whether the new roof is to be of paper or felt composition or a hot mopped job. Where a hot mopped job is to be applied over one of a lapped seam type all old laps that have become loose should be made flush and solid by cementing the under side of the laps. Figs. 2, 3, 4, and 5 show recommended methods for making the flashings, counter flashings, saddles, and raggle blocks encountered on the average roof. The ideal mopping material should leave a body that will seal up all small holes and create an elastic roof without joints, seams, or laps. The materials to be used will depend upon local conditions of weather, acids, gases, or alkalies to be encountered.

An all-purpose patcher for small leaks and seam repairs must be such that it can be applied satisfactorily by unskilled labor. Several of these patchers are on the market that can be used equally well, whether the roofs be felt or paper, composition, built-up, or metal. Such a compound can be tested for waterproof qualities by placing it in water and subjecting the two to hydraulic pressure. The ideal patcher will not mix nor allow penetration under such a test.

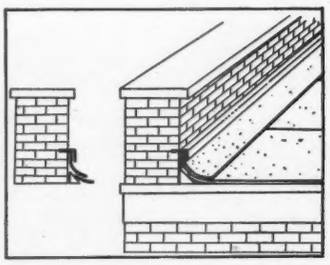


Fig. 4—Construction and method of installation of metal flashing on a brick wall.

The best results are obtained in making repairs of this nature with a surrounding temperature of from 60 to 70 deg. F. Precautions similar to those outlined for a complete re-roofing job—pertaining to cleaning, spudding, and coating the undersides of seams—also should be adhered to on the patching job. In addition to the regular coating standard practice calls for placing a patch of heavy duck or muslin over all holes in excess of ¼ in. in diameter. Too much emphasis cannot be placed on the importance of cleaning the surface on which the new roof or patch is to be applied, for not only is cleaning essential in providing a satisfactory bonding surface but it increases substantially the available covering area. For sealing wall flashings, joints in copings, pointing up old chimneys, gutters, troughs and

guy wire anchors, a standard calking gun will speed up the job and give a deeper penetration of the material.

Most metal roofs, whether flat or corrugated, will respond to the same patching methods as those outlined for paper, felt, or built-up roofs. All rusted and corroded sections must be cut out and replaced before patching and mopping. This procedure also should be applied to flashing, skylights, and cornice walls. Metal roofs that have not deteriorated beyond repair can be covered with a cloth and mopped job. This work, however, should be done by a skilled roofing crew experienced in this particular covering. Such a roof also should be painted about every two years. At best roofs of this type (black and galvanized sheet steel) are costly to maintain and should be used only where a more rigid and substantial type is out of question because of the nature of the building and the equipment covered.

A valuable roofing development recently has come to the fore in the form of steel roofing, the sheets of which are treated successively with asphalt, asbestos felt, and waterproof paint either prior to installation or after it is in service. Such roofing is immune to acids, alkalies, fire, and ordinary corrosion and wear.

Inspection and Roof Records—One of the most costly errors in connection with the maintenance of roofs is to entrust their care and repair entirely to a few laborers. Though the material and methods set up should be such that they can be satisfactorily used by unskilled labor it is essential, if costs are to be held to a minimum, that their supervision be controlled rigidly and followed up by the maintenance engineer or one delegated by him.

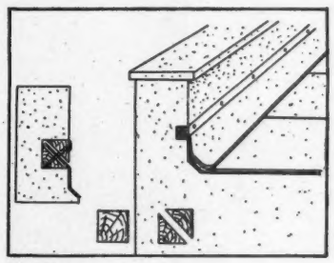


Fig. 5—How a raggle block or wood strip should be set in a concrete fire wall and how the roofing and flashing are attached to it.

It is common practice to have an annual inspection late in the Spring of roofs and buildings, spreading out the repairs found necessary in the inspection over the summer months. Leaks and other roof defects make their appearance during the winter months, with alternate freezing and thawing and with the early Spring rains. Unless some systematic means are provided for tabulating such troubles as they come up the majority of such items either will be forgotten entirely or only a hazy recollection of them will remain when the regular spring inspection is made.

A chart such as that shown in Fig. 6, filled in as these troubles come up, is insurance that the inspection will be really effective and that nothing will be overlooked. In this specific chart E.E. stands for East End, C. for center, S.E. for South East, and so on. Letters in the second column represent the points of the compass.

Without suitable roof records much time is wasted referring to files for questions that constantly are arising in regard to when a roof was laid, what is its guarantee, what material was used, and comparisons with other roofs. An up-to-date roof record data sheet, such as that shown in Fig. 7, gives an immediate picture of all plant roofs and serves as a guide and ready reference for all purposes.

Fig. 6—When properly filled out the roof inspection sheet shown will give at a glance the condition and repair record of all plant roofs.

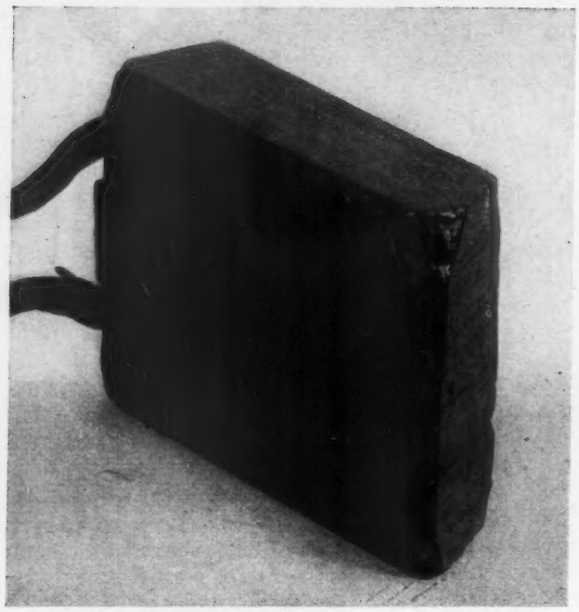
Fig. 7—Permanent data concerning each roof in a plant can be collected on the roof record data sheet shown. When used in conjunction with the roof inspection sheet any roof information desired can be obtained quickly.

ROOF INSPECTION SHEET

BLDG.		ROOFING MATERIAL	FLASHING	CORNICE	GUTTER	VALLEY	PENTS	SKYLIGHTS	CRIMNEYS	LOCATION	DISPOSITION
1	N	2			E.E.			2 E.E.		E.E.	Temporary repairs made 1/4/32
	S	Ply									
	E	felt								C.	
	W									S.E.	Check guarantee - see chart
2	N										
	S	Tar									
	E	and									
	W	gravel									
2B	N	2									
	S	Ply									
	E	felt									
	W	composition									
3	N										
	S	Corrugated									
	E	asbestos									
	W										

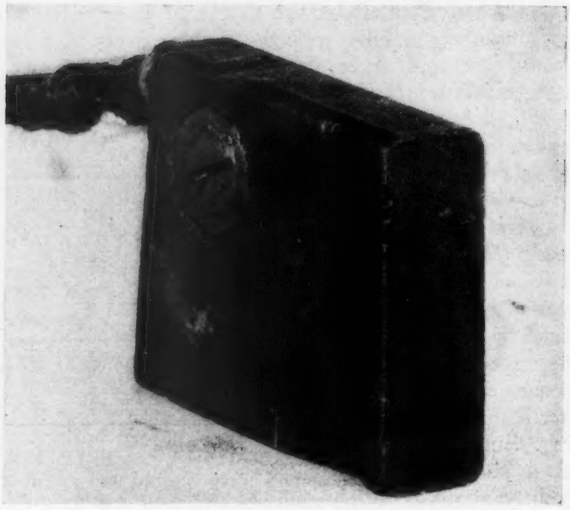
ROOF RECORD DATA

BLDG.	SIZE	MATERIAL	ROOFER'S NAME	GUARANTOR	GUARANTEE	DATE LAID	EXPIRES	FILE NO.	REMARKS
1	240x80	Built up felt	J. Smith Co.	J. Smith Co.	20 yrs.	Apr. 1915	Apr. 1935	26	See order R-6241
1A	30x40	Corr. asbestos	Jones Bros.	None	None	.....	.....	13	
1B	90x120	Composition	Butler	Butler	10 years	May 1928	May 1938	44	Inspect in extreme temp.
2	50x100	"	Ourselves	.....	.....	May 1930		14	Trial



Destruction to brush caused by high mica. Insulation between the commutator bars should have been undercut.

Poor fit in the brush holder caused chattering, which led to this brush failure.



Carbon Brushes

PART III (CONCLUSION)

J. S. MARCUS

Sales Manager
Electro-Nite Carbon Company
Philadelphia, Pa.

"SELECTIVE action" is the term applied to the unequal carrying of the load current by the brushes. Primarily due to brush contact, it may arise from varying brush pressures, condition of the face, sticking brushes, unequal shunt losses, and the like. Resistance of the contact between the brush and the commutator decreases (*a*) as spring tension is increased; (*b*) as the current density at the contact increases; and (*c*) as brush temperature increases (except beyond the glowing point), since carbon is negative in its temperature-resistance relation.

Serious selective action is indicated by sparking of some brushes on a stud, but not of others, together with heating of some brushes, even to the point of glowing, along with heating and burning of the shunt wire.

The selectivity becomes cumulative, even to the point of destruction of the brush. Assume that each brush on a stud is to carry a load of 50 amp. Because of varying contact resistance, the load will distribute itself, say 40 amp. on one brush and 60 amperes on the other. The more highly loaded brush will acquire the higher temperature, and because of the negative resistance coefficient of carbon, the internal resistance of the brush drops, resulting in a corresponding assumption of more load.

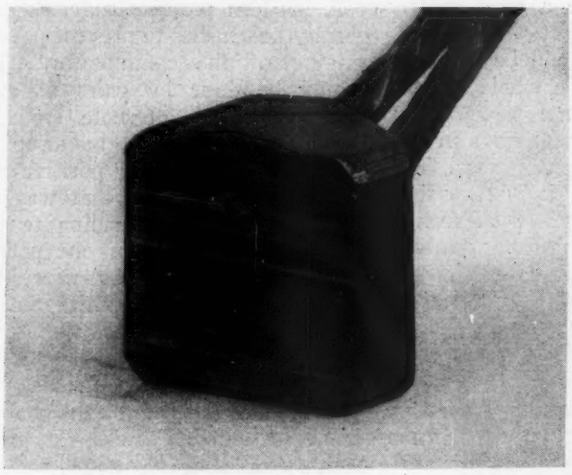
It will be noted, then, that the brush which has the higher temperature in operation is *not* the brush at fault (unless, of course, heat is due to shunt failure) but is taking the load that some other brush on the stud should be carrying.

If the faces of the brushes have a uniformly good contact area, and we can assume a uniform composition in the brush material and uniform shunt drop losses, the main cause of the initial inequality of currents is unequal pressure on the brushes. When new brushes are put on a machine, and at regular intervals thereafter, the spring tension should be checked by a small spring scale. Friction goes up as pressure increases, and in some cases the extra friction loss from higher pressure will overbalance any gain through lower contact drop.

The lowest brush pressure giving good contact will, in general, give the best all around results. Most graphite brushes run with a pressure as low as 1¼ lb. per sq.in., while electro-graphite brushes, because of their almost total lack of abrasive property, may require a pressure of two or more pounds per sq.in. to secure the necessary cleaning action on the commutator. The recommendations of the manufacturer

should be followed for given brush material and conditions, but the accompanying table offers a good average for all-around service.

Even when selective action is not so serious at to cause total destruction of some brushes, it very seriously affects brush life. The brushes carrying the higher load break down at the face, until the contact resistance becomes sufficiently high to throw the load to other brushes, which in turn also break down at the face. The burned material is carried away by the commutator, and the life of the brushes is shortened.



This brush was run too short; the shunt is cutting into the commutator.

A cause of selective action too often overlooked is the loss in the shunt connection to the brush. If this connection is not such that the loss in all brushes is uniform throughout the life of the brush, a difference in resistance will occur which with its cumulative action will cause brush failure. Burned holders and brushes burned away on the sides result from loose shunts, or from loose terminal screws.

Brush Selection

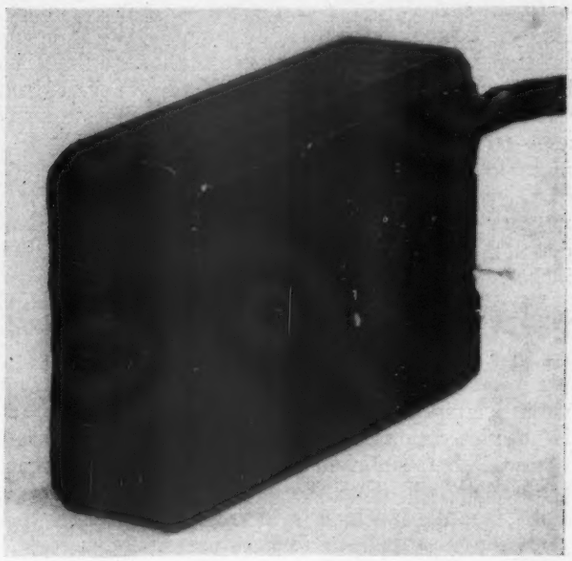
The ideal characteristics of a carbon brush are (*a*) high contact resistance for commutation; (*b*) high current carrying capacity for design economy; (*c*) low coefficient of friction for low friction loss and reduced heating; (*d*) low inertia to insure the maintaining of good contact under the action of spring pressure; and (*e*) long life for economy in operation. It is often necessary to use a brush in which certain characteristics are predominant, at some sacrifice of the others.

In the average selection of a proper grade, three chief factors are considered: (*a*) necessary carrying capacity of the brush, and speed of the machine (peripheral and angular velocity of the commutator); (*b*) general characteristics of the machine; (*c*) abrasiveness required.

(*a*) From the load the brush must carry, and the peripheral speed at which that load must be carried, a particular class of material is chosen.

(*b*) A consideration of the characteristics of the particular machine will then further limit the class of material to within a few grades. For practical purposes, the past performance of the machine may be studied, and much learned from the grades previously used that were unsuccessful and how they failed; what grades improved operation and how; the conditions of atmosphere, overload, and the like, under which the machine is to run; the general design, whether interpole or non-interpole, completely or partly cross connected. If under most conditions the machine commutates well, it may be assumed to be of good inherent characteristics, and vice versa. The better the total of these electrical characteristics, the lower the permissible contact drop, while the poorer the overall conditions, the higher the necessary contact drop.

Poor fit on commutator caused this failure.



(*c*) The required abrasiveness will depend on the condition of the commutator, the characteristics of the machine, and atmospheric conditions. If the mica in the commutator is properly undercut, the necessity of abrasion to keep it down is eliminated. However, even though the mica is undercut, it is necessary sometimes to use a brush with some cleansing properties in order to remove the blackening and burns on the bars that result from poor commutation due to electrical faults.

When the commutator is not undercut, the hardness of the mica may often be determined from the knowledge of the operator, or to a fair degree from the age of the machine, because the mined sheet mica in the older machines is much harder than the newer artificial product built up from small flakes and binder. This

RECOMMENDED BRUSH PRESSURES

	Lb. per Sq.In.
Stationary machines	1¾–2¼
Sliprings — graphite or electro-graphite brushes	1¾–3
Sliprings — metal-graphite brushes	4 –6
Elevator and mill type motors	2 –3
Crane and truck motors	3 –6
Railway motors	4 –7

artificial mica also hardens with age, and from machine heat.

A proper soft graphite brush will not cut mica, without the deliberate addition of abrasive material, but will remove its own deposit and thus over a long period slightly wear the commutator.

The angular speed of the armature must be considered as a factor in abrasion, for in a high speed machine a given bar is subjected to brush action many times more than in a slow speed machine, and the abrasiveness per brush must be lower as the r.p.m. increases.

A very decided difference in the degree of abrasiveness is required for hard mica than where merely blackening has to be polished off. A partial refilling of the bars will often introduce two hardnesses of copper, and the hard bars must be held down.

As an example of brush selection, take a 4,000 kw. rotary converter on traction service, subject to several high overloads of short duration, with the following constants: voltage—600; amperage—6,750; maximum load—10,000 amp. (20-second duration); speed—360 r.p.m.; commutator diameter—68 in.; mica—undercut; brushes—168, $2\frac{3}{4} \times 1\frac{3}{4} \times \frac{3}{4}$ inches.

The current density on the brushes, then, is 61 amp. per sq.in., and the peripheral speed is 6,400 ft. per min. Both load and speed demand a graphite brush. Since there is no mica condition, there should be required but sufficient abrasion to remove deposit from the soft material. But the machine is in traction service and so subject to flash-overs which will cause some burning. Therefore it is advisable to have a slight degree of abrasiveness to repolish these occasional burns rather than repeatedly to sand the commutator. Furthermore, a slightly higher contact drop than that of the slightly abrasive graphite will be of assistance in stabilizing commutation in the extreme load swings of this service, so a material of high cross resistance is preferable to plain graphite. Now, since such material will be low in thermal conductivity, the combination of high density, high speed, and frequent surges will cause heat faster than it can be dissipated. Therefore shunts much heavier than would be required merely to carry the load will be used to aid in conducting heat from the brush.

Without any reference to unusual operating conditions, or inherent machine characteristics that might affect the grade, we have arrived at a graphite brush, of laminated structure, slightly abrasive, and heavily shunted.

Brush Installation

1. Never mix two grades of brushes indiscriminately on the same machines, because the difference in specific and contact resistances will cause an unequal distribution of load current in the brushes, those of lower value eventually burning up.

2. It is advisable to polish the commutator before installing a new set of brushes, removing all burns along the edges of the bars. Use only very fine sandpaper, for carborundum or emery are conductors. For final finish, use a hard canvas pad under pressure.

3. Each brush should be properly sanded in, so that the whole surface will be in contact, the properly set neutral maintained, and no overload placed on a partial contact area. The very finest sandpaper is best for this, the final strokes being in the direction of rotation only to prevent rounded brush tips. After sanding, the brushes should be well wiped, especially on the face, to remove loose, abrasive material. The commutator and slots should be cleaned.

4. The spring pressures should be equally adjusted so that each brush carries its proper share of the load. The actual pressure required depends on the service, grade, and local conditions, but should be little more than sufficient to maintain continuous good contact. With large metallic brushes extra pressure must be applied to those on the underside to compensate for the actual weight of the brush. Tension should be checked at least once a month, and certainly after a flash-over. Tension should never be increased haphazardly, in an attempt to stop sparking, became in that way abrasion may be greatly increased and friction raised to produce a dangerous temperature.

5. The brush holder studs must be evenly spaced around the commutator and parallel to the segments. Holders should be set to clear the commutator by $\frac{1}{8}$ in. to $\frac{3}{16}$ in. to avoid chattering that might be caused by long leverage from the box end.

6. Brushes should have a good sliding fit in the boxes, but should not be so loose as to rattle. The more nearly radial the brush angle is, the more important this becomes. On graphite, and more so on metallic brushes, the clearance must be larger than for carbon or electro-graphite to allow for greater expansion under temperature rise.

7. Modern practice suggests staggering the brushes to prevent possible ridging of the commutator. This should be done by pairs of studs rather than on alternate studs, in order that each path be swept by an equal number of positive and negative brushes. In that way any eddy-current action tending to take place under brushes of one polarity will be more or less neutralized by the brushes of opposite polarity in direct line with them.

8. After installing a new set of brushes, particularly on rotary converters and generators, the machine should be allowed to run for several hours at no load, if possible, and then the load gradually applied. This permits the brushes to assume the exact curvature of the commutator before assumption of full load.

9. Use no lubricants. Oil affects the mica, causes an accumulation of dirt in the slots of undercut commutators, and raises the contact drop too high. Proper grades of brushes require no lubrication.

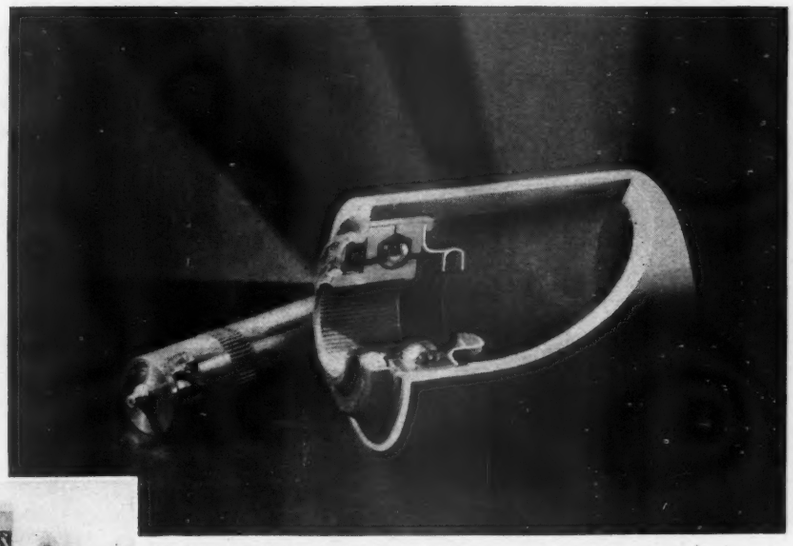
10. At least once a month brushes should be inspected to make certain that they are all sufficiently long and that they are all free to move easily under the proper tension.

One of the worst examples of brush maintenance neglect the writer has ever seen.

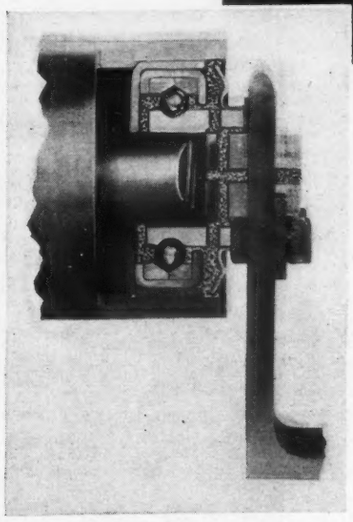
Preventive Maintenance of Materials Handling Equipment in Foundries

THOMAS A. BISSELL
Assistant Editor

IF THERE are other industries that depend as much upon their handling equipment as does the foundry it can be said with assurance that there is no other industry in which severe operating conditions make the job of its maintenance a larger and more specialized task. Here abrasive, conductive, and magnetic dust; heat; vibration; corrosive fumes; shock and abrasive loads make the maintenance cost of this equipment a substantial part of tonnage cost. In the mass production type of foundry as much as 75 per cent of the total maintenance cost may be charged to materials handling equipment. This expense is one of the few that can be controlled by foundrymen in these days when cost reduction is all-important.



Courtesy Matheus Conveyer Company



Courtesy Standard Conveyor Company

Two types of gravity roller conveyor designed for severe foundry service. Sand and grit are prevented from entering the grease-packed ball bearings by a grease seal on one type and a steel and felt-washer labyrinth seal on the other type.

Adequate maintenance of handling equipment at minimum cost becomes a question of most effectively protecting the equipment against these severe conditions, and normal deterioration and wear. It may be obtained by: (1) maintaining a periodic and well organized system of preventive inspection and service and (2) using modern equipment designed especially to withstand the rigorous service of foundries.

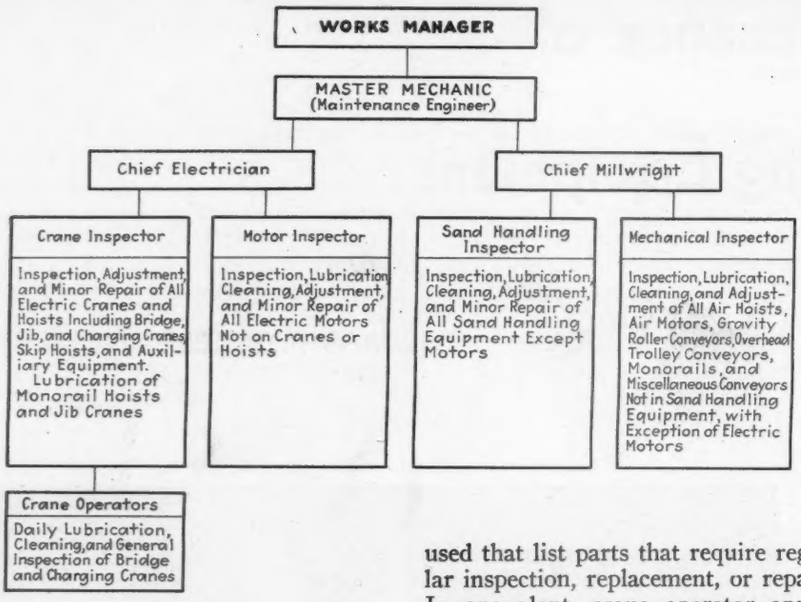
Abstract of paper to be presented at the Management, Maintenance, and Materials Handling Congress, sponsored by divisions of the A.S.M.E. cooperating with the American Foundrymen's Association and Materials Handling Institute, May 4-5, 1932, Hotel Statler, Detroit, Mich.

Organization for Preventive Maintenance — A detailed knowledge of maintenance costs is the first requisite of such an organization. It will function best when the maintenance cost of any piece of materials handling equipment can be ascertained at any time.

The second requisite is to obtain an alert, protective attitude toward the equipment on the part of the maintenance inspectors, production foremen, and operators. In a successful method in use for producing this attitude the maintenance inspector is made responsible for inspection, lubrication, cleaning, adjustments, and the replacement of parts resulting from normal service, and the foreman is held accountable for operating abuses.

Experience indicates that the best organization for preventive maintenance of handling equipment in foundries is one in which an inspector makes regular rounds of a definite list of equipment for which he is responsible. In many cases it has worked out most advantageously for this inspector to lubricate, clean, and adjust the equipment as well as to make minor repairs while on patrol.

To insure systematic and thorough inspection the use of inspection sheets that list all items to be checked or serviced on each piece of equipment is recommended. When used properly such sheets insure against the neglect of important items, pro-


WORKS MANAGER
MASTER MECHANIC (Maintenance Engineer)
Chief Electrician
Chief Millwright
Crane Inspector
Inspection, Adjustment, and Minor Repair of All Electric Cranes and Hoists Including Bridge, Jib, and Charging Cranes, Skip Hoists, and Auxiliary Equipment. Lubrication of Monorail Hoists and Jib Cranes
Motor Inspector
Inspection, Lubrication, Cleaning, Adjustment, and Minor Repair of All Electric Motors Not on Cranes or Hoists
Sand Handling Inspector
Inspection, Lubrication, Cleaning, Adjustment, and Minor Repair of All Sand Handling Equipment Except Motors
Mechanical Inspector
Inspection, Lubrication, Cleaning, and Adjustment of All Air Hoists, Air Motors, Gravity Roller Conveyors, Overhead Trolley Conveyors, Monorails, and Miscellaneous Conveyors Not in Sand Handling Equipment, with Exception of Electric Motors
Crane Operators
Daily Lubrication, Cleaning, and General Inspection of Bridge and Charging Cranes

Typical organization for preventive maintenance of materials handling equipment in foundries.

vide permanent records, and place responsibility beyond the slightest doubt. An accompanying illustration shows a typical organization chart for preventive maintenance of foundry handling equipment.

The remainder of this abstract will be devoted to a more specific discussion of preventive maintenance methods as applied to various types of foundry materials handling equipment.

Electric Cranes and Hoists (Bridge, yard, jib, monorail, charging, and skip hoists)—Because crane breakdowns are extremely costly and hazardous most foundries have a more highly developed organization for crane inspection and maintenance than for any other type of handling equipment.

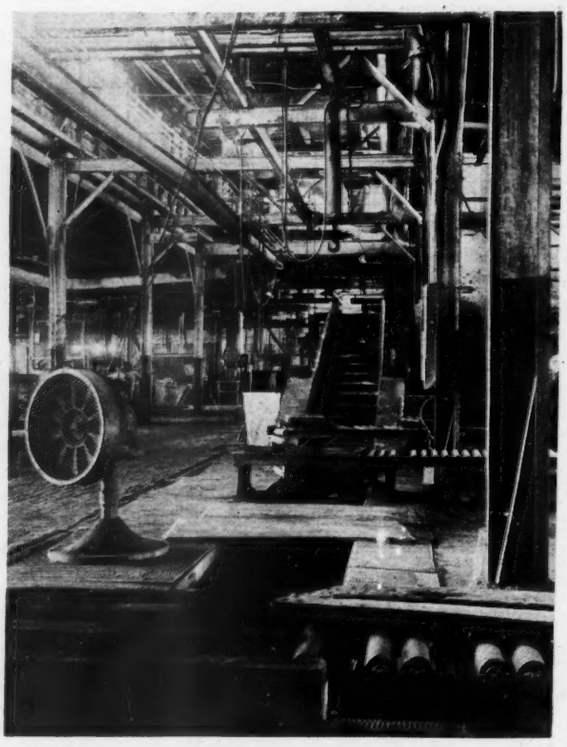
Standard practice is for each crane operator to lubricate and clean his crane thoroughly each morning on company time. During this period he usually makes a general inspection of the equipment and reports any defects found to the crane inspector. Efficient crane maintenance depends more upon the attitude and qualifications of the operators than does that of any other type of handling equipment. For this reason too much attention cannot be given to their selection and training. The best results from crane inspection are obtained when inspection sheets are used that list parts that require regular inspection, replacement, or repair. In one plant, crane operator applicants must pass a physical examination and go through a period of supervised practice before getting jobs.

In a large steel foundry the chief electrical inspector has full authority over all crane operators, even though they are paid by the departments in which they operate. This authority includes the duties of hiring and discharging them. As a result the operators refuse to lift loads that are beyond the capacities of their cranes or to indulge in other practices that are injurious to the equipment. Protection of the equipment comes first with them because it is what their boss primarily is interested in. Each operator must be versatile enough to assist in all repair jobs on his crane, whether the repair is in charge of an electrician, millwright, or machinist. Crane operators are paid on a rate that is in proportion to the capacity of their cranes. Thus the highest rate is paid to the heat crane operator. A heat crane graduate is in line for the job of crane inspector and repair man.

This crane inspector is constantly patrolling the runways of the foundry's 19 cranes so that he inspects every crane every day. The inspector also has authority over the operators. Once a week, when the cranes are shut down, a more detailed inspection and servicing is given to each crane by both the crane inspector and the chief electrician, and a written report is turned in.

In another plant this special detailed inspection is made by three electrical inspectors who may be accompanied by the maintenance engineer or the head of the safety department. Each inspector serves for three months, a new one being added each month. After inspection a typewritten report of the condition of each crane is made out. From these reports each crane is given a percentage rating. A crane with no defects is rated at 100 per cent. Each defect—loose bolts, loose material on walkways or bridges, excessively worn bearings, poor lubrication, a general dirty condition—counts so much against the crane. Ratings are posted each month. The result is that the routine inspectors and operators vie with each other to make the best showing. Of course, defects found by the committee's inspection are eliminated immediately.

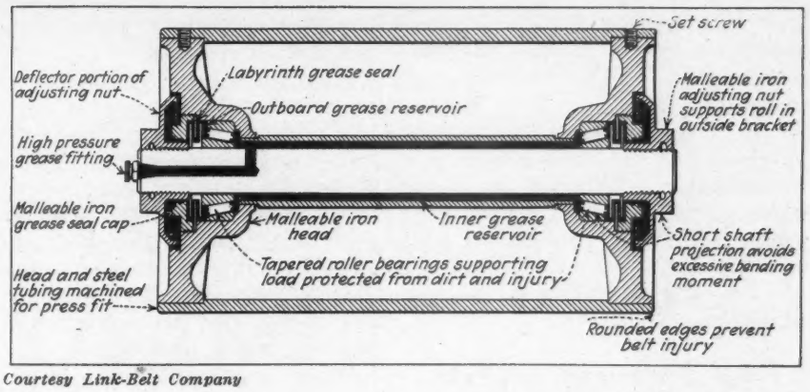
In an Eastern gray iron foundry



Steel apron conveyors stand up well under the severe service of carrying hot sand, sprues, and gaggers from shakeouts.

where large molds are handled by the cranes the shocks of overload and overbalanced load caused distortions of the crane armature shafts of as much as one-eighth of an inch, and several armature burnouts resulted. The problem was solved by substituting chrome-vanadium steel armature shafts for those of high-carbon steel regularly supplied as crane equipment.

Cable wear is faster on smooth than grooved drums because of the added friction of winding and unwinding the first layer of cable. Consequently, grooved drums should be pitched so that the rows of cable do not rub together. Hoisting cable should be lubricated regularly with a thick semi-plastic compound or heavy oil applied hot so that it will harden and stay in place. A good method is to run the cable through a tank of this heated oil. Most cable contains a hemp or steel core that is impregnated originally with a chemically neutral lubricant. If this core is allowed to dry the cable is likely to wear or crush quickly and absorb moisture. The lubricant retards corrosion, reduces internal friction, and decreases external wear.


Set screw
Deflector portion of adjusting nut
Labyrinth grease seal
Outboard grease reservoir
Malleable iron adjusting nut supports roll in outside bracket
High pressure grease fitting
Malleable iron grease seal cap
Malleable iron head
Inner grease reservoir
Short shaft projection avoids excessive bending moment
Tapered roller bearings supporting load protected from dirt and injury
Head and steel tubing machined for press fit
Rounded edges prevent belt injury

Courtesy Link-Belt Company

Cross-section of heavy-duty foundry belt conveyor idler. Its tapered roller bearings are sealed against the entrance of dust and grit. Distribution of grease is shown by the solid lines.

Although worn trays must be replaced regularly, the cost of handling small molds on a sliding tray conveyor is low for this type of service.

Yard cranes operate under a different set of conditions than indoor cranes because they are subjected to the corrosive effects of the elements instead of the dust and fumes inside the foundry. For this reason protection against moisture is a major consideration. A coat of paint at least every two years is one of the requirements of this job.

The same general methods can be applied to the preventive maintenance of hoists as those recommended for cranes. Here lubrication, limit switches, cables, and drums are the principal items of inspection and service.

Motors — The necessity for regular (usually daily) inspection, lubrication, and service of all open motors is recognized in most foundries. All dust and moisture should be removed either by wiping, blowing, or suction. Where the dust is especially abrasive the blowing method should be avoided unless very low pressure dry air is available because high pressure moist air will cause the dust to cut and deteriorate the windings.

Care should be taken in lubricating open motors that oil or grease does not get into the windings. Such grease and oil is best removed by wiping or spraying the parts with naphtha or gasoline. The operating temperature should be checked either by feeling with the hand or by the use of a thermometer. Motor and starting box contacts should be cleaned. Such inspection is supplemented in many foundries by an annual or semi-annual complete overhaul of every motor.

There is no better example of the reduction of maintenance cost through modern equipment than that effected when an open motor in continuous service in the average dusty atmosphere of a foundry is replaced by one of the fan- or duct-cooled, totally inclosed type that positively shuts out all dust, dirt, and moisture from its interior. For intermittent service, such as usually is required of hoists and cranes, totally inclosed motors have worked out most economically. Fans or ducts are unnecessary here because the thermal capacity of these motors is adequate to absorb the dissipated heat and, therefore, operating temperatures seldom rise above that of the ambient air.

Inspection of these motors is necessary only at relatively long intervals, and the job of dust removal is eliminated. Their labyrinth- and piston-sealed, grease-packed ball bearings require lubrication but once in every two or three months. Good maintenance dictates that such motors be opened, cleaned, and overhauled at least once a year. Dust-proof control equipment is a fitting auxiliary to these motors. Where dust conditions are not a troublesome factor, such as in a compressor room, open motors with sealed-sleeve or ball bearings will give the most economical service.

One foundry reports that its totally inclosed fan-cooled motors have oper-

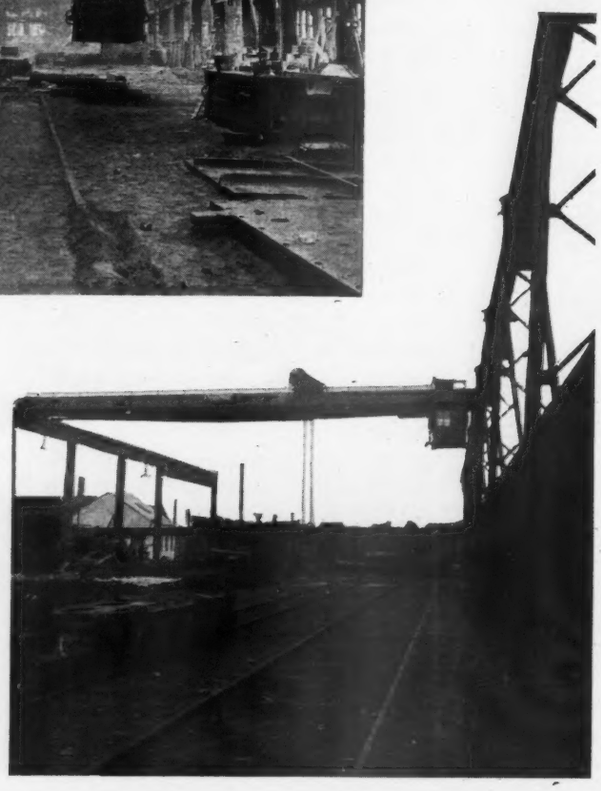
ated satisfactorily for three years with absolutely no attention or maintenance cost. This company estimates that it would save $100 a month if it substituted this type of motor for its 115 open motors now in operation. Although it is not good maintenance to neglect even such high-grade equipment, this example is factual evidence of the cost reducing possibilities of this type of motor.

Power Transmission Equipment— Belt, chain, gear, and V-belt drives should be inspected and cleaned regularly. Slippage, misalignment, excessive wear, and incorrect tension should be looked for at this time. Leather belts should be cleaned and dressed periodically to preserve them and prevent slippage.

Sheet steel housings around such drives not only promote safety but also protect them from dust. Gear and chain drives especially must be protected against the wear caused by sand, metallic particles, and dust. Such wear reduces the tooth width of gears and sprockets and increases the pitch of chain. The result is jerks and shocks that are so harmful to bearings, shafts, and motors.

Where large reductions in speed are necessary, totally inclosed reduction units equipped with dust-tight ball or roller bearings of the worm-gear, herringbone-gear, or spur-gear type give practically maintenance-free service. Usually lubrication every three to six months and overhaul and cleaning at long intervals is all the attention that they require.

Cranes handling heavy flasks of varying weight must be guarded especially against the shocks of overload.



Yard cranes should be painted at least every two years to protect them from corrosion.

Sand Handling Equipment — Preventive maintenance of sand handling equipment in the modern foundry usually is a big enough job to have one or more inspectors constantly patrolling the equipment. In many cases the motor inspector is responsible for the motors and controls so that the sand handling inspectors are responsible for the remainder of the equipment.

Where common journal bearings are used they usually must be lubricated several times a day. If these bearings are provided with grease cups this operation is performed by turning them down until they are under pressure. This action forces out any grit that may have worked its way into the bearing ends. When filling these cups care must be taken that no foreign matter gets into the cups with the grease. Equipping the grease cups with high pressure fittings simplifies the job by permitting them to be filled with a grease gun. The inspector's job also includes keeping the equipment clean and adjusted and reporting the need for replacement or repair. An adequate supply of replacement parts is essential to efficient maintenance. If a pug mill or beater forms part of the installation the inspector usually cleans it out at the end of the day to reduce the wear on paddle tips. Adjustment consists of removing the slack or stretch on all take-ups and drives.

Where belt conveyors are used to carry material from the shakeout to a revolving screen, belt wear generally is extremely rapid owing to the hot lumpy sand full of gaggers and sprues that it must carry. In such cases belts often have had to be replaced every six months. Although special high temperature belts are on the market that are claimed to stand up under this service, steel apron conveyors are most generally used for this purpose. To prevent overloading and jamming of this apron conveyor one foundry has installed a leveler consisting of a 2-in. plank held at the desired level. If the material jams behind the leveler a shear pin in the drive will give before the conveyor is damaged.

Paddles of revivifiers, plows of mixing mills, trunnion rollers of revolving screens, vibrating screens, tempering belts, magnetic pulleys,

(Please turn to page 208)

MAINTENANCE ORDER SYSTEMS

Part V—Good Management Watches Small Maintenance Details

G. I. ROSS

Chief Engineer, MacDonald Bros., Inc.
Boston, Mass.

THE PLANT described in this article is smaller than any previously considered in this series. Its maintenance problems are, in fact, of comparatively minor importance. However, it was thought expedient to include it in our "case studies" because it furnishes an example of a well developed system, and shows the attention paid by good management to the lesser details of plant operation.

There are two kinds of maintenance orders issued at this plant. One is the "Foreman's Expense Order," issued for repair work which will cost not more than $5, and the other is the "Shop Expense Order," issued for work which will exceed $5 in cost.

"Case studies" of maintenance order routines. The plant discussed is one of 200 employees, manufacturing instruments.

The "Foreman's Expense Order" (Fig. 6) is made up and distributed as follows:

Original — Prepared by foreman desiring work to be done, and signed by him; forwarded to Plant Superintendent; filed in Plant Superintendent's office.

Duplicate—Signed by foreman and sent, together with triplicate, to maintenance foreman and then to timekeeper; retained by timekeeper.

Triplicate—Reverse side used by timekeper for posting labor expended on job; forwarded to Cost Department for posting material used, and for completing cost records.

The "Shop Expense Order" shown

LABOR				MATERIAL			
DATE	MAN NO.	AMOUNT		DATE	UNIT	DESCRIPTION	AMOUNT

TOTAL COST _____ ACCT. NO. CHARGED _____

FOREMAN'S EXPENSE ORDER

TO DEPT. _____ FROM DEPT. _____

DATE _____ 19 NO.

PLEASE DO THE FOLLOWING WORK WHICH IS ESTIMATED TO COST LESS THAN $5.00

_____

_____

_____

_____

_____ %

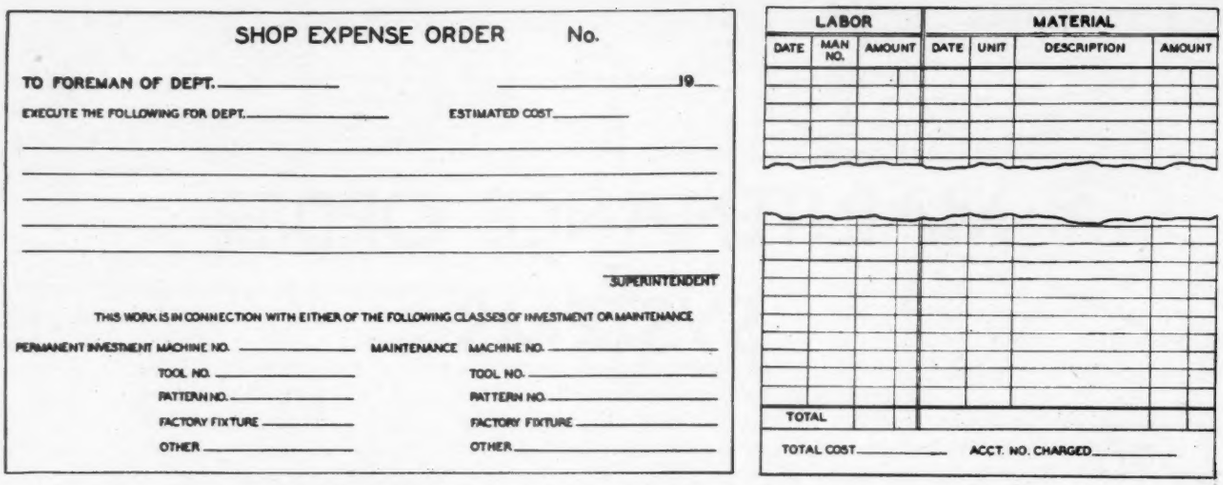
THIS WORK IS IN CONNECTION WITH EITHER OF THE FOLLOWING:

MCH. NO. _____ TOOL _____ PATTERN _____

FIXTURE _____

_____
FOREMAN

Fig. 6—Foreman's Expense Order. The obverse of the original, duplicate, and triplicate is shown above, the reverse of the triplicate, left. Actual size, 6½x4¼ inches.



SHOP EXPENSE ORDER No.

TO FOREMAN OF DEPT. _____ _____ 19__

EXECUTE THE FOLLOWING FOR DEPT. _____ ESTIMATED COST _____

SUPERINTENDENT

THIS WORK IS IN CONNECTION WITH EITHER OF THE FOLLOWING CLASSES OF INVESTMENT OR MAINTENANCE

PERMANENT INVESTMENT MACHINE NO. _____ MAINTENANCE MACHINE NO. _____

TOOL NO. _____ TOOL NO. _____

PATTERN NO. _____ PATTERN NO. _____

FACTORY FIXTURE _____ FACTORY FIXTURE _____

OTHER _____ OTHER _____

LABOR			MATERIAL			
DATE	MAN NO.	AMOUNT	DATE	UNIT	DESCRIPTION	AMOUNT
TOTAL						

TOTAL COST _____ ACCT. NO. CHARGED _____

Fig. 7—Shop Expense Order. The obverse of the original, duplicate, and triplicate is at the left, the reverse of the original and duplicate, right. Actual size, 8x5 inches.

in Fig. 7 is made up in triplicate and distributed as follows:

Original — Prepared by foreman desiring work to be done; sent to Superintendent together with duplicate and triplicate; approved by Superintendent and sent to Cost Department for posting material costs on reverse side.

Duplicate—Approved by Superintendent; sent to maintenance foreman; forwarded to timekeper for posting labor costs on reverse side; forwarded to Cost Department upon completion of job; labor costs posted to original and order closed out.

Triplicate—Retained by Superintendent.

In preceding articles, the problem of controlling maintenance expenditures before they are actually made was not considered. However, in many companies the need of such control is recognized. Usually two types of orders are used—one for minor jobs, the other for jobs involving large expenditures. Next month we shall dicsuss this question in detail.

■ ■ ■

Preventive Maintenance of Materials Handling Equipment in Foundries

(Continued from page 206)

cleaning brushes, deflecting plows, and elevator buckets are other rapidly wearing or troublesome parts that should be checked regularly and kept in stock. Spare bucket elevator belts should have all buckets attached ready for instant installation.

The belt life of many belt conveyors has been shortened materially by poor loading or unloading conditions. Ideal loading is obtained when the material is deposited on the belt at the belt speed and in the direction of belt travel. Where the load is allowed to drop gently on the belt its rubber cushion has enough elasticity to resist cutting, whereas abrasive material dropping from an appreciable distance onto the belt rapidly cuts it to pieces.

Decking, brushes, and other devices that keep materials from spilling on belt conveyor pulleys more than pay for themselves in increased belt life. If sand is allowed to accumulate upon rolls and idlers, the under coat of the belt may wear through long before the upper side has shown wear. This condition must be guarded against especially where gummy core sand is handled. Misalignment of pulleys and idlers frequently causes excessive wear of the edges of belts. Hard running or jammed idlers resulting from neglect of lubrication lead to cutting of the belt, excessive wear of the idlers, power waste, and increased belt tension. A recent development worthy of mention is a rubber brush for cleaning belt conveyors. It resembles a spiral gear of wide pitch and will stand up considerably longer than other types.

Again in the case of belt, apron, flight, bucket, reciprocating, and pivoted-bucket conveyors and, in fact, almost all sand handling equipment the use of sealed, grease-packed, anti-friction bearings has decreased maintenance and operating costs. These bearings require lubrication by a high-pressure grease gun but once in three months. Because the movement of the grease is from the inside out under pressure it is impossible for grit to get into the bearings. Decreased power consumption and longer life of rolls and belts has followed in every instance where these modern bearings have replaced the babbitted or journal type on belt conveyors. Construction details of a belt conveyor idler equipped with grease-sealed tapered roller bearings are shown in an accompanying sketch.

The purpose of grease in an anti-friction bearing is to protect the highly polished surfaces and to keep out foreign matter, rather than to serve as a means of friction and to carry loads or to dissipate heat as is the case with babbitted bearings. Therefore, although harmful, lubrication neglect of anti-friction bearings is not as costly as with journal bearings where the oil film must carry the load.

(Please turn to page 210)

Open and Crossed Field Coils In Rotating Apparatus

A. C. ROE

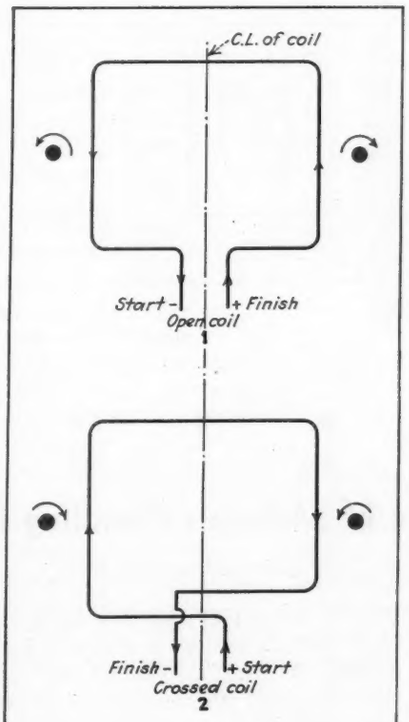
Renewal Parts Engineering Department
Westinghouse Electric and
Manufacturing Company
East Pittsburgh, Pa.

SHUNT field coils are used in some d.c. motors and generators, a.c. generators and synchronous motors, that require a special arrangement of the starting and finishing leads of each coil, to simplify the method of connection when assembling the coils in place.

The lead arrangement results in two types of coils that are generally designated as "open" coils and "crossed" coils. When ordering less than a full set of coils as spares for a machine that is fitted with coils of this type, care should be taken to specify which type of coil is required, and the number of each.

When connecting field coils in series, the polarity of adjacent coils must be opposite, as North, South, North, and so on. When the coils are wound alike, the polarity is reversed by crossing the leads on every other coil. However, with machines of large capacity the coil leads are too cumbersome to be crossed; in these cases the coils are wound differently, bringing the leads out in a position most advantageous for short connections between adjacent poles. This necessitates the use of open coils, crossed coils, special open coils, and special crossed coils.

An open coil (see Figs. 1 and 4) can be defined as one in which the starting and finishing leads do not pass beyond the center line of the coil. A crossed coil (Figs. 2 and 5) is one in which the starting and finishing leads pass beyond the center line of the coil.

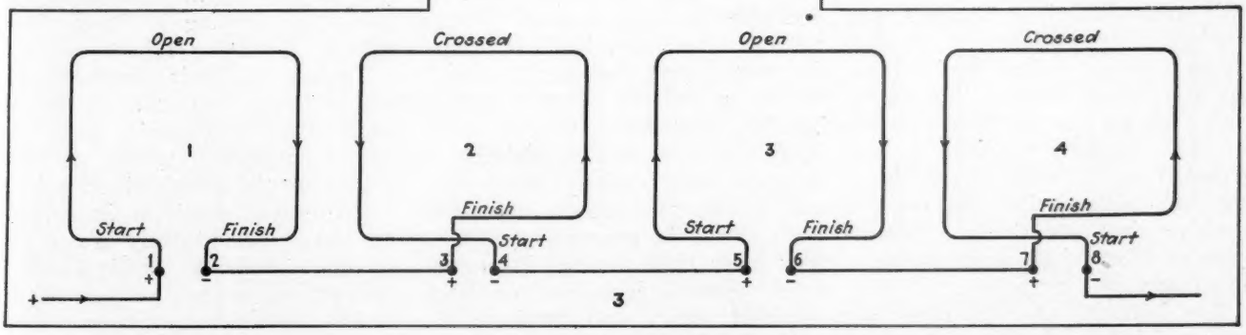


In Fig. 3 is shown the use of open and crossed coils; coils *1* and *3* are open, and *2* and *4* are crossed. Note the straight, short jumpers, *2-3, 4-5,* and *6-7*; without the crossed coils these jumpers would have to be longer, and if made of copper, have special shapes.

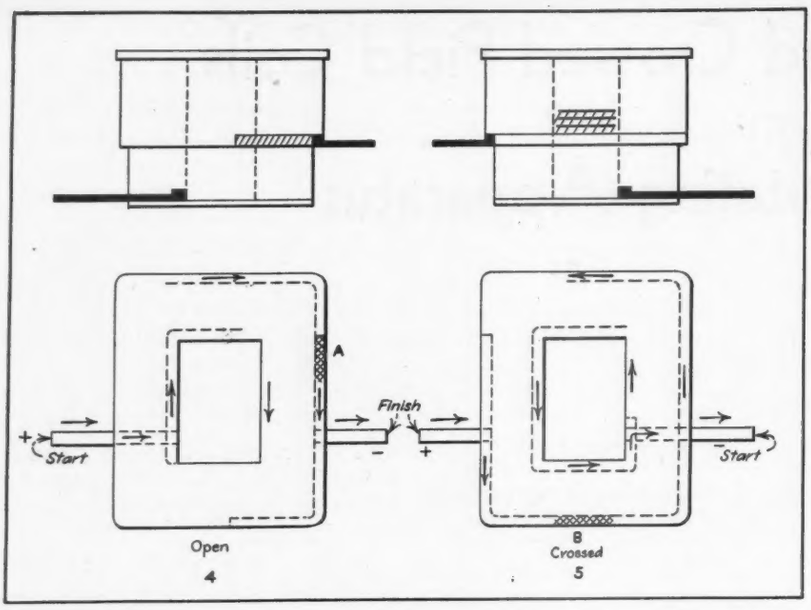
An open, wire-wound coil of the type used on revolving fields is shown in Fig. 4. Strap copper is fastened to the wire and brought off the coil as leads. A crossed coil for the same machine is shown in Fig. 5; the two coils are in the proper position for connecting together. Note that the finishing leads are both at the same height and in line for easy connection.

In many cases the open and crossed coils used in a machine are all alike —half the set are crossed coils and the other half open coils. However, in some instances two special coils are used where the coils are connected to the collector rings. Figs. 6 and 7 show a special open coil, and a special crossed coil. The special feature is that the starting leads are brought out at the front of the coil, instead of at the side, as Figs. 4 and 5 show.

In Fig. 8 is shown how a machine would be connected that uses standard



Figs. 1, 2, and 3—Distinguishing characteristics of open and crossed coils, with method of connecting the two types in a machine.

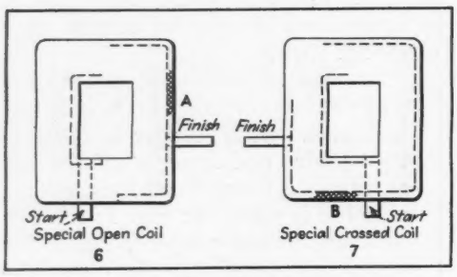


Figs. 4 and 5—Open and crossed, wire-wound coils used in revolving fields.

and special open or crossed coils. Other arrangements may be used, differing only in the location of the leads on the individual coils. In general, a crossed coil can always be detected by noting whether the finishing lead passes over the center line and past the starting lead.

One feature of construction that can be used to check whether a coil is open or crossed is the method used to secure the lead to the last two or three turns of all coils. It is the practice to solder the last turns and the finishing lead turn together, close to where the finishing lead is brought off the coil.

On open coils, the soldered section is on the side of the coil, as at *A*, in Figs. 4, 6, and 8, where the shaded part indicates the location of the soldered joint. This is on the side of open coils, and on the front, *B*, of crossed coils.



Figs. 6 and 7—Here the leads are brought out at the front of the coil.

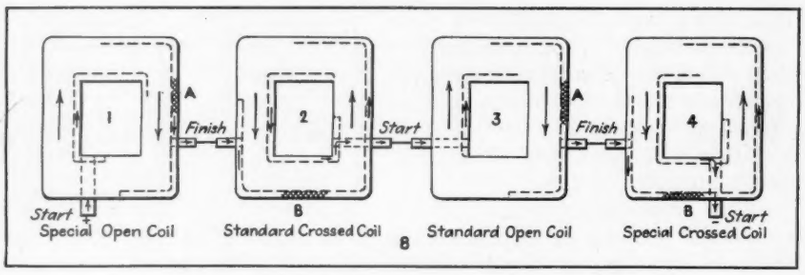


Fig. 8—Method of connecting standard and special open and crossed coils in a machine.

■ ■ ■

Preventive Maintenance of Materials Handling Equipment in Foundries

(*Continued from page 208*)

Mold and Castings Handling Equipment — In the past three or four years gravity roller conveyor has been developed especially for foundry service. If this equipment is applied properly its maintenance cost will be negligible. It is provided with grease-sealed or -packed ball bearings that exclude all foreign matter. Like other anti-friction bearings they require lubrication with a grease gun but once in three months. Similarly, a gradual flow of grease from the inside of each bearing out makes the entrance of abrasive dust impossible. Several types of this equipment are shown in accompanying illustrations.

The bearings of both types are protected from molten metal by overlapping rolls and metal shields. Where continuous pouring is being conducted the conveyor channels frequently are notched out at the roll shafts so that rolls damaged by severe pour overs can be replaced at once.

Where delicate molds are to be carried at least four rolls should be under each mold at all times. Gravity roller conveyor often has been blamed for mold jarring that later was found to be caused by uneven bottom boards. For heavy, delicate molds many foundries find it advisable to interpose rails between the conveyor and molds. Overloads and shock loads should be guarded against for they often have resulted in crushed rolls. Several foundries completely overhaul, clean, and lubricate this equipment once a year.

One foundry that uses thousands of feet of this grease-packed, ball-bearing gravity roller conveyor has to replace but an average of ten bearings a year. Most of these bearings failures are caused by bad pour overs. A large steel foundry has used several lengths of this equipment for two years carrying 11,000-lb. molds without a bearing failure.

Because of their simplicity and low maintenance cost air hoists are used widely for foundry mold handling. Inspection usually is made daily after the foundry is shut down, for it consists mostly in listening for air leaks. Such leakage is a telltale of most air-hoist trouble, such as jammed valves or worn packing. Inspection procedure is the same for air motors except that lubrication is more frequent.

De-ionization in Industrial Circuit Breakers

CARL HEYEL
Assistant Editor

De-ion chamber for the 225-amp., 600-volt a.c. circuit breaker. In multi-pole switches there is a chamber for each pole. The arc current magnetizes the steel plates.

APPLICATION of the "de-ion" principle of arc extinction in circuit breakers of small and medium size has been made recently. Heretofore use of this principle has been limited to high-tension circuit breakers for power transmission, such breakers having been introduced by the Westinghouse Electric & Manufacturing Company in 1929.

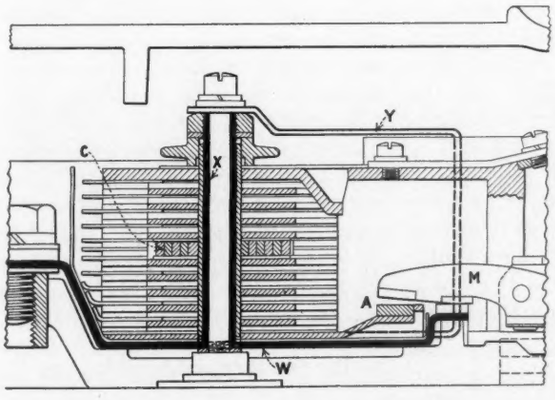
Because of this extension in application it becomes advisable for the electrical engineer in the industrial plant to understand the de-ion principle, which is explained briefly as follows:

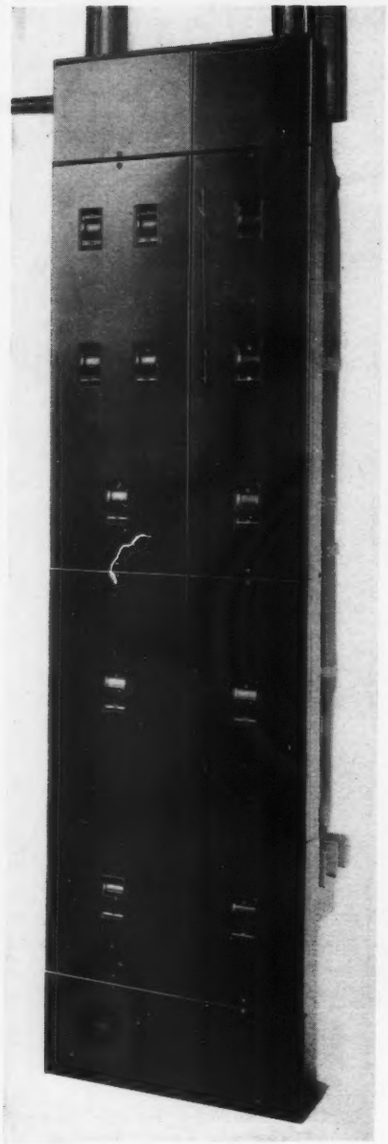
When a short a.c. arc passes through zero current, the dielectric of the arc space recovers the ability to withstand a few hundred volts almost instantly; later increases in the dielectric strength are obtained at a much slower rate. Moreover, the first 250 volts are borne almost entirely by a thin layer of gas touching the negative terminal. This layer rapidly becomes de-ionized as positively charged particles of the gas are attracted to the negative terminal where they give up their charge. The dielectric strength of the whole space slowly increases as this layer of gas becomes larger, and as ions in other parts of the arc space disappear by recombination.

In the larger sizes of circuit breakers the arc is broken up into many small arcs in series by means of a stack of copper plates, so that as much use as possible is made of the space close to each one of a series of cathodes. De-ion breakers are, therefore, essentially a.c. devices. In d.c. circuits the arc is continuous; there is no cyclical zero current point, with instantaneous recovery of strength at that point to withstand comparatively high voltages, as is the case with a.c. For this reason the d.c. ratings of these breakers is less than one-half of their a.c. voltage rating for the same current capacity.

Arc extinction in the de-ion chambers of the 25-volt a.c. industrial breakers depends upon the rapid recovery of dielectric strength alone; but in the 600-volt sizes the arc must

De-ion chamber for the 600-volt a.c. breaker. When the switch is closed (position shown) the circuit is from the left terminal through a solid metallic conductor "W," and so through the main contacts "M." When the switch is opened, movement is such that arcing contacts "A" close before the main contacts open. Then after the main contacts open, the circuit for an instant is completed through the center of the stack along "X"; thence along "Y" to the arcing contacts. Thus when the arcing contacts open the arc will be drawn into the chamber by the magnetic field set up by the current through "X." The arc-spinning coil "C" is in series with the two inside plates.





Switchboard panel designed for de-ion breakers. These switchboards are flexible as to future changes in capacity. Since the width of multi-pole switch units is proportional to the number of poles, neatly fitting, easily interchangeable construction is afforded.

be whipped rapidly about over the surface of the plates to prevent their melting. This is accomplished by means of a small coil between the inner plates which, setting up a radial flux, spins the arc over the plate surfaces until the first current zero is reached. In both of these sizes each element of the de-ion chamber consists of a copper plate fitted into a steel stamping which, when stacked, forms with the others a magnetic circuit on all sides of the copper except at the bottom. Whenever an arc is formed by opening the contact, current must flow in a conductor through the center of this stack. It sets up a magnetic field which draws the arc through a grooved opening into the center of the stack and thus on to the copper plates. It is then, in the 600-volt breaker, that the coil in the center of the stack is energized by the arc, and the "arc spinning" is produced.

The small-amperage, 125-volt a.c. breakers employ a very simple, two-plate extinguishing chamber into which the arc is flashed without magnetic action.

No new design features are embodied in the operating mechanism of these breakers. In all switches quick make and quick break are provided, and the contacts are trip-free of the handle in all positions from full open to full close. Bi-metallic, thermal-trip elements, one for each pole in the multi-pole switches, are employed. Their thickness and alloy characteristics provide proper inverse-time delay. In addition to the thermal trip with time delay, an instantaneous trip is provided in the breakers of 250-volt a.c. rating and above. All trip units are available completely assembled. To change the tripping value of a breaker it is merely necessary to install a trip unit equipped with heaters of the proper value, calibrated in the factory.

Main contacts are of silver alloy. In the 250-volt a.c. and larger sizes, an additional magnetic action is provided to increase contact pressure as the overload current rises above the normal value. But as soon as this current approaches zero during the first half cycle, the contacts are permitted to separate readily. Thus the contacts always start to open approximately at current zero.

Considerable saving of space is obtained with the distribution switchboards and panels which have been designed for these circuit breakers. Moreover, since all breakers between 50- and 225-amp. ratings are identical with the exception of the trip unit, which determines the rating, a switchboard installation will lend itself readily to future changes in capacity. The width of multi-pole switch units is exactly proportional to the number of poles; hence easily interchangeable construction is provided.

■ ■

Common Colds and Air Conditioning

AN ACTUAL survey of some industrial plants during the winter of 1929-30 showed that 40 per cent of the absenteeism was caused by the common cold. The economists who have studied the result of this survey and other significant data tell us that the common cold costs the American people ten billion dollars a year. The doctors tell us that the proper air conditioning of our homes, offices and plants would eliminate at least some portion of these colds with the consequent reduction of a percentage of the ten billion dollars economic loss.

In addition, it seems reasonable to suppose that it is just as important to clean the air we breathe as it is to humidify it, although as yet, we have not obtained any authoritative research or other data which tells us physiologically just how this affects our health. However, in the ordinary state of life in the cities in which we live, fresh air loses its significance. You have only to take a trip in an aeroplane and see how our cities show up on the landscape as great black smudges to realize the condition of the air which we breathe. This city air is polluted with smoke, unburnt gases from furnaces and chimneys, sulphur dioxide gas, fumes from incinerators and carbon monoxide and oil fumes given off by the thousands of automobiles in our streets. The so-called fresh air which we breathe in our cities may be likened to the so-called fresh sparkling spring water which flows through a dump.

The average man breathes normally twenty times a minute, respiring 366 cu.in. of air per minute, or more than 95 gallons of air per hour. We spend a great deal of time, effort and money in seeing that our food comes to us from its source and is prepared for our table in a sanitary condition. We spend a great deal of time, effort and money in making certain that the water supply to our cities is free from dirt and germs. It seems to be a reasonable assumption that air conditioning, which washes and filters the air which we breathe, is just as vital to our health as the sanitary condition of our food.

P. L. Davidson, Carrier Engineering Corporation, before the A.S.M.E.

MAINT-O-GRAPHS

Ways of increasing efficiency of equipment ◆ Ideas that will help plant men

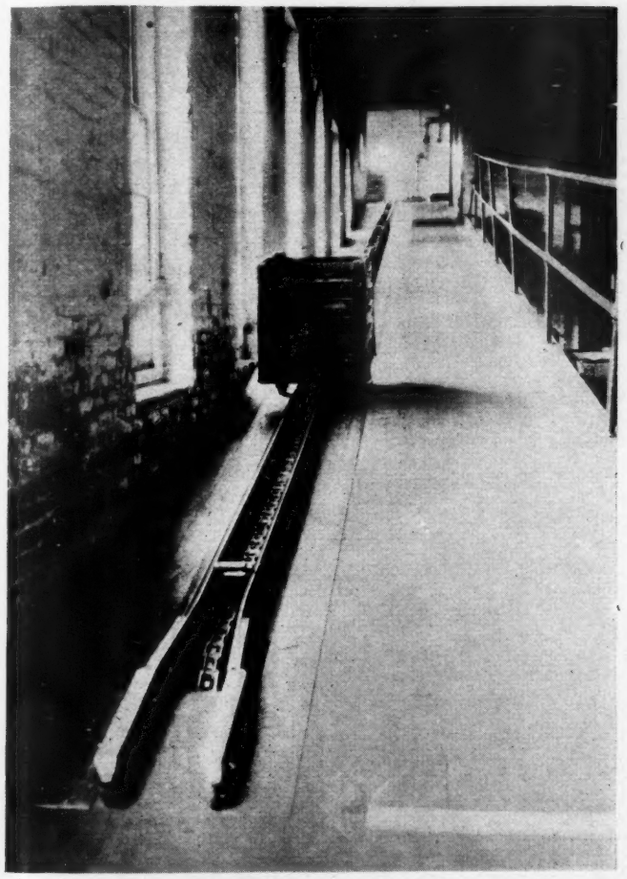
News of books and events ◆ ◆ Practical solutions of plant problems

Unusual developments in apparatus design

CONTRIBUTIONS ARE WELCOME

Chain Conveyor Transports Hand Trucks

SOURCE, Bigelow-Sanford Carpet Company



Slow, uncertain deliveries and tired backs were frequent when workers had to push trucks of yarn up the 11-per cent grade of the 110-ft. ramp shown.

Now a chain conveyor pulls the trucks up the incline at a rate of 100 ft. per min. The flat steel surfaces provide a smooth roadway for the trucks' casters, and the chain guides keep the casters in position. Dogs spaced as shown on the chain engage stops fastened on the bottom of the trucks. When the trucks reach the upper level the dogs disengage the stops, and the trucks roll out on the floor.

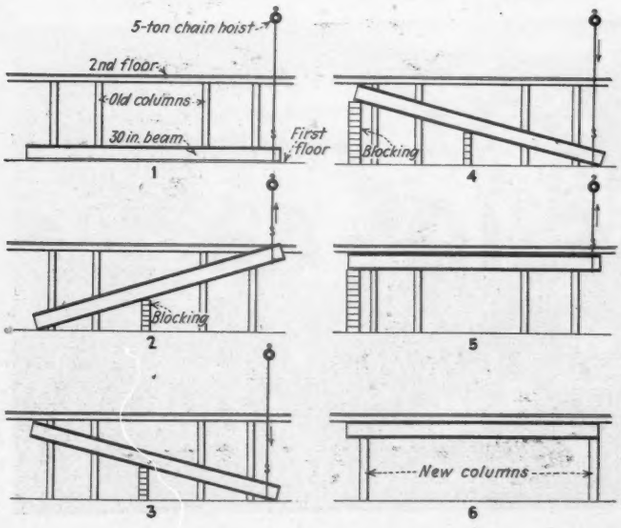
The conveyor is automatic and reversible, being controlled by pushbuttons. It is driven by a 5-hp., 1200-r.p.m., induction motor through a speed reducer and gears.

The Maintenance Department Takes on All Comers

FRED D. HARTFORD, Denver, Colo.

In many process industries, the chemical business for example, the maintenance department frequently is called upon to tackle urgent jobs that ordinarily would be done by an outside contractor. When apparatus must be kept running or when the hazards of the work require experienced men the maintenance engineer gets a call from the front office.

Recently a chemical company decided to put in some new, large machinery on the ground floor of one of its



buildings. To do this job it was necessary to install a pair of large, wide-flange beams and two new columns to take the place of four old columns supporting the second floor. The lower story was crisscrossed by acid piping and high voltage conduits and, to make the work more difficult, the second floor carried sensitive equipment that could not be shut down even for a few moments.

A steel erection contractor looked over the job and refused to take it unless the piping and wiring were dismantled and the machinery shut down so that his men would be in no danger. This demand the management refused to grant and, consequently, it passed the job to the maintenance department.

A carefully picked crew of men, who knew all the dangers of corrosives and who could "eat gas" if the occasion demanded it, tackled the task. Because of the weight of the beams, some 8,000 lb. apiece, the constricted quarters, and the limited amount of tackle available, careful planning for safety, speed, and low cost was the first order of business.

The beams were paired so that they could be placed on either side of the old columns which carried the load until the new supports were placed.

The sketches show the sequence of operations used to raise one of the beams. The arrow parallel to the load chain on the chain hoist indicates the direction of the last movement of the chain.

The Right Color at the Right Time

SOURCE, Western Electric Company

A general view of the machine layout and conveyor installation for handling cotton to and from the textile rewinding and doubling machines in the cable department is shown in the illustration.

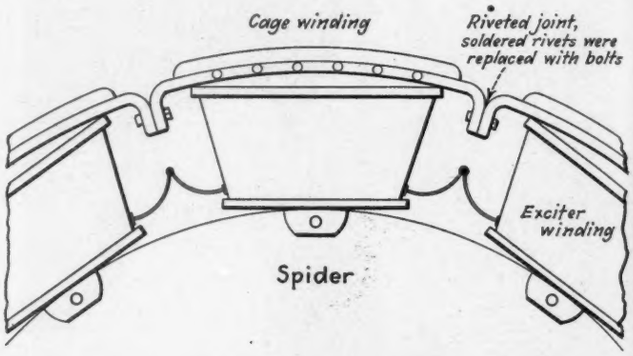
The conveyor provides a continuous supply of the six different sizes and eight different colors required to rewind and double 800 size and color combinations. The material is carried to and from the machine operator by an attachment bearing numerous pins. The upper pins carry supply cotton and the lower ones remove the finished product.

The pins carrying supply cotton are divided into sections, so that each section carries all of the colors for a specific size of cotton and alternate sections carry different sizes. The material is placed on the conveyor at one end, and the finished product automatically removed at the other. The take-off end of the conveyor is shown in the illustration.

Repair of Synchronous Motor Cage Winding

GRADY H. EMERSON, Birmingham, Ala.

After going through the usual starting procedure the operator of a 300-hp., synchronous motor-generator set was surprised to find that the machine would not come up to speed and "pull in," even though it had operated



Section of eight-pole rotor of 300-hp., 2,200-volt synchronous motor, showing construction of troublesome auxiliary cage winding.

successfully before being shut down the night before. The set furnished d.c. power for a coal mine and, when it would not start, the mine had to be shut down because its hoist was coupled to this generator with a Ward-Leonard control. Because the set was designed especially for this duty none of the other generators could operate the hoist successfully.

Immediately the trouble was reported to the electrician, who examined the starting transformers and field rheostats and found them to be in good condition.

Except that the starting current was excessive, everything about the machine seemed all right. After several attempts at starting had failed the motor's auxiliary cage winding was examined, and several hot joints were found. A temporary repair was tried without opening the riveted ring joints between each pole. Because the solder had been burned by the excessive current occasioned by an overload the joint would not tin and this method was abandoned.

Finally each overheated joint was spread apart after removing its rivet, and the contacting surfaces were

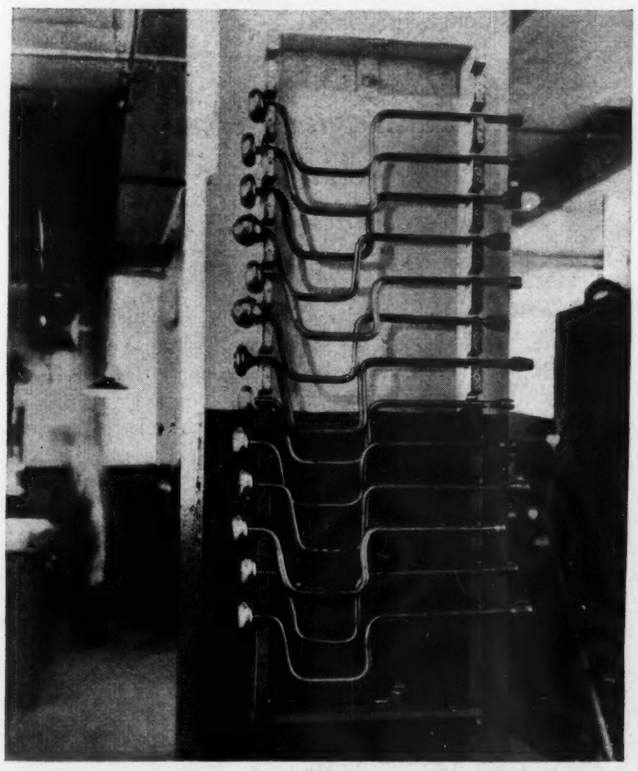
cleaned carefully and tinned. These joints were inaccessible in the assembled machine because the stator was located over the rotor between the pole pieces. Because it was impossible to put the rivets back successfully we used round-head bolts commonly called "stove bolts." These bolts were tinned easily and were tightened while the soldering iron was on each joint. To facilitate this operation the joint was clamped together and held until it was cool. Each nut was soldered also.

After repairing these joints the machine came up to speed easily. Therefore it was decided to service all of the joints in this manner. While performing this job about two-thirds of the joints were found to be corroded. While removing rivets, metal shields were placed over the fields to prevent solder and paste from getting onto the windings. Although it took several hours to do this job we felt satisfied when we compared the cost with that of removing the stator and large bearing pedestals, and re-aligning these parts.

After starting the motor several times we found that it did not lag and that starting operation was smoother than it had been for some time. The joint was constructed so that centrifugal force tended to close it.

Convenient Wrench Rack

SOURCE, Electric Motor Repair Shop, Springfield, Mass.



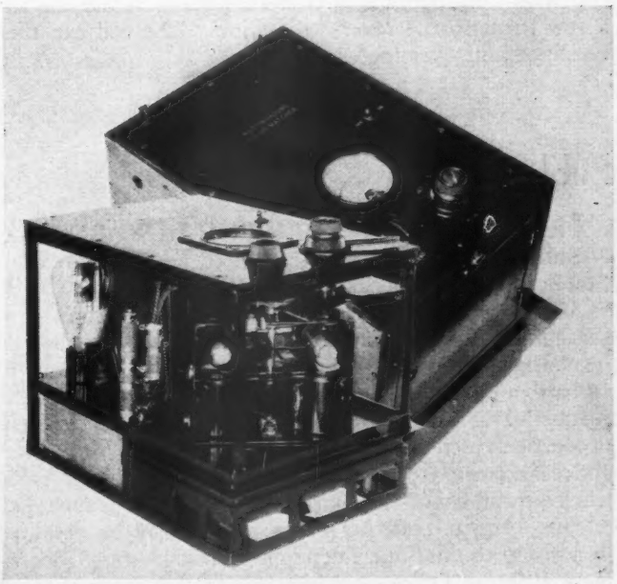
No time is lost hunting for wrenches here. The rack is on a building column convenient to both the machine shop and the assembly bay. It contains wrenches for all the bolt sizes ordinarily found on standard motors.

Another Use for the "Electric Eye"

SOURCE, Westinghouse Electric and Manufacturing Company

More sensitive than human eyes, the color matcher with its never-erring "electric eye" is now in process of development in the Westinghouse research laboratories to assist industry to duplicate colors in manufacturing processes.

Reflected light is put to work in this new instrument.



The quantities of light reflected respectively by two samples of color are measured by two "light-sensitive" photo electric cells with a meter to indicate the degree of match.

Samples are tested under red, green, and blue light in succession. If they match under these three colors, they probably will match under any lighting condition.

The greatest use of the color matcher will be made in the textile and paper industries and in those industries which manufacture molded and pressed materials, tile, floor materials, enameled metals, and steel tiles.

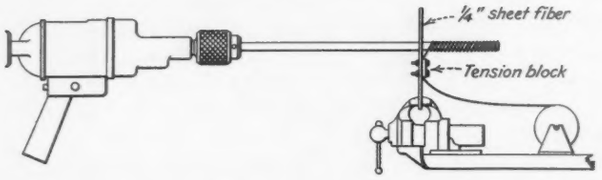
Winding Heating Elements

SAMUEL OVANDO, San Francisco, Calif.

A method of winding heating elements or springs by means of an electric drill is illustrated in the accompanying sketch. The rod is forced forward as the wire feeds between the preceding turn and the sheet fiber bearing in which the rod revolves. A slight tension opposing this motion is supplied by the operator's hand as he controls the electric drill. Lengths which can be wound in this manner are limited only by the length of the rod used. However, the free end of the rod must be supported

during the operation to prevent its whipping as it spins. This may be accomplished by placing a length of ½-in. conduit in a position for the rod to run into as it creeps forward from the guide hole in the sheet fibre.

In order to loosen the turns sufficiently to remove the



coil when long lengths have been wound, rotate the rod a few turns in the reverse direction. The coil can then be slipped off over the end very easily.

Publications

PROPERTIES OF FIBER BUILDING BOARDS —Bulletin M132, has been announced by The Bureau of Standards, U. S. Department of Commerce.

Studies made on various fiber building boards consisting of representative samples of wall boards and insulating boards are reported. The composition, manufacture, and uses of the boards are discussed briefly, the results of laboratory tests tabulated, and the different properties, such as strength, density, water resistance, and expansion, treated in detail. A review of previous work on wall boards by Clark and Conley also is included.

This 14-page bulletin, priced at 5c., may be obtained by writing to the Superintendent of Documents, Government Printing Office, Washington, D. C.

COMPLETE OSCILLOGRAMS OF TRANSFORMER CHARACTERISTICS — The seventeen large, clear photographs in the 34-page Engineering Bulletin, Research Series No. 37, of the Engineering Experiment Station, Lafayette, Ind., serve admirably to give realism to the reader's conception, usually obtained by means of graphs and vector diagrams, of transient phenomena and non-sinusoidal wave forms as they exist in the various common transformer connections.

No new information is contained in this paper; its value consists in giving photographic confirmation of transformer phenomena already adduced in classic theoretical analyses. An oscillographic study of transformer characteristics conducted by G. V. Mueller, Assistant Professor of Electrical Engineering, Purdue University, is described.

CONCRETE BLOCK PILASTER STRESSES— Pilasters are the thickened or otherwise strengthened portions of building walls needed beneath horizontal beams or girders to support the concentrated loads at these points. "Strength of Concrete Block Pilasters Under Varied Eccentric Loading," Bulletin 60 of the Engineering Experiment Station, The Ohio State University, by J. R. Shank, research professor, and A. D. Foster, research engineer, reports tests upon pilasters of concrete block, Haydite block, and gravel concrete block.

Seven specimens of block were made into piers of two sizes: 12x16 in., 10 ft. high with 8-in. walls, and 16x16 in., 14 ft. high with 12-in. walls, the maximum heights permitted by most building regulations. The testing machine used was a two-screw universal column-testing machine of 500,000 lb. capacity. A special device for varying the slope of the loading and consequently the eccentricity was designed by Prof. Shank.

The tests showed that the ultimate strength of masonry is about one-half that of the unit; maximum unit stresses under the bearing plate at working load and full beam deflection are about four times the average working stress over the entire plate, the lateral deflections at working loads, which are independent of the moduli of elasticity, are not of serious consequence; internal bending due to eccentric loadings extends down into the piers for distances proportional to the moduli of elasticity; the wall sections adjacent to pilasters will take up their share of the bending throughout the entire length of the pier, and 80 per cent of their share of the compression load at mid-height.

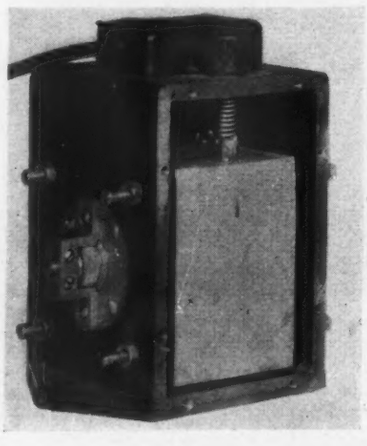
The bulletin is of 35 pages, and is amply illustrated with graphs, charts, and photographs. A price per copy of 50 cents has been set, but a limited number have been offered for free general distribution upon application at the Engineering Experiment Station, The Ohio State University, Columbus, Ohio.

Miniature Seismograph Measures Vibration in Machinery

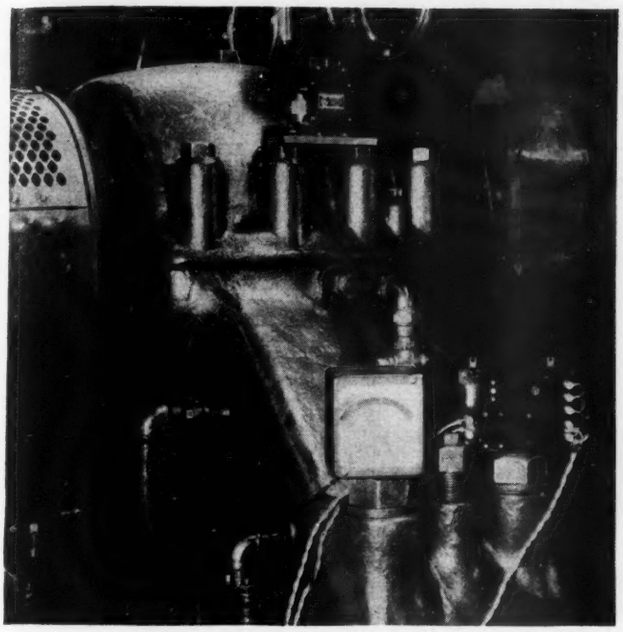
SOURCE, General Electric Company

Like the seismograph, a device for recording earthquake tremors, an instrument known as the vibration detector has been developed for the measurement, in thousandths of an inch, of vibration in steam turbines or other machinery to which the instrument is bolted.

Within the instrument's case is suspended a block of lead. Two tension springs on the top and four springs on each side of the block hold it in position. The outside shell of the detector vibrates at the same period as does the machine to which it



Vibration detector with cover removed to show suspended lead block.



Typical mounting of vibration detector and attendant equipment on testing machinery.

is attached but the lead weight, because of its mass and low natural frequency, remains fixed in space.

On opposite sides inside of the lead weight are imbedded two coils. Fastened to the outer shell in front of each coil is an adjustable piece of magnetic steel. The coils in the weight are energized by 500-cycle alternating current, and the air gaps between the coils and the pieces of magnetic steel are adjusted so that the two coils are electrically balanced. Then the amount of current going through the coils depends on the distance of the steel pieces from them. Therefore a zero reading of the indicating instrument is obtained when there is no vibration.

Vibration of the machinery to which the detector is attached causes a swaying of the outer shell of the instrument and, consequently, a variation in the distances between the coils and the magnetic pieces. These differences cause variations in the flow of the 500-cycle current. In the indicating or recording instrument these current variations are translated into vibration readings in thousandths of an inch.

Another development that resembles the device previously described is a pressure detector. A small case incloses a similar coil with the magnetic piece as a diaphragm just beyond it. The magnet is threaded so that it may be screwed to the vessel containing the gas or liquid, the pressure of which is to measured. A similar unit is used as a dummy for circuit calibration.

Variations in pressure cause movements of the magnetic diaphragm and, consequently, changes in the readings of the instrument. Low pressure changes are subjected to the diaphragm direct for measurement, whereas the changes of higher pressures, up to 2,000 lb. per sq.in., are recorded by the use of intermediate cylinders and pistons.

By replacing the diaphragm of the testing unit by a ribbon diaphragm to which is attached a feeler rod, the device can be used as another type of vibration recorder. In such applications the test unit is held in the hand so that the feeler rod rests against the vibrating member. The detector circuit is such that a variation in pressure exerted on the diaphragm by the hand does not interfere with measurements as low as five cycles per second.

Such a detector was used recently in investigating the vibrations of a new all-electric ship. The analysis showed that the three-blade propeller was responsible for whatever vibrations existed and that no vibrations were produced by the electric machinery.

A Permanent Cement for Steam Pipes

CHAS. R. WHITEHOUSE, Standards Engineer
Holtzer-Cabot Electric Company, Boston, Mass.

To make a permanent cement for use in stopping leaks in steam pipes where calking or plugging is impossible, mix black oxide of manganese and raw linseed oil, using enough oil with the manganese to bring it to a thick paste. Apply the mixture to the pipe or joint at the leak. It is best to remove the steam pressure and to keep the pipe sufficiently warm to absorb the oil from the manganese. In 24 hr. the cement will be as hard as the pipe itself and will last indefinitely. This mixture has been used successfully on innumerable jobs.

Rewinding D.C. Armatures

"Rewinding Data for Direct Current Armatures," by G. A. Van Brunt, Associate Editor, *Maintenance Engineering,* and A. C. Roe, Renewal Parts Engineering Department, Westinghouse Electric and Manufacturing Company, gives directions for taking and recording data which should enable a winder with a reasonable amount of experience to rewind any type of d.c. armature. Rules governing various types of windings are included, and a recording form is shown for each type. The chapter on marking armatures to prevent errors, prepared in an easily understood way, should be of great practical value; the four chapters on frog-leg windings form one of the most complete sources of information on this subject available.

Motor winding diagrams usually seem to defy simple treatment; wave and lap windings, when presented diagrammatically, inevitably tend to become a rather confusing maze of lines. The winding diagrams in this book are large and well drawn, and so can be traced out with comparative ease. In addition, the book is amply illustrated with photographs and drawings, and many winding tables are given. The last chapters deal with rewinding materials, core slot and end insulation, dipping and baking, and armature banding.

Publisher is the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price is $2.50.

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

MAY, 1932

Recrimination Insurance

OUR COVER message this month is meant to be very much to the point. Obviously, in many plants there will come a day of consternation, when output demands cannot be met until the house has been put in order.

The warning is sounded for the benefit of those maintenance engineers who have supinely accepted orders that *no* money may be spent. Economies are in order, certainly; but economy, as well as spending, must obey the law of diminishing returns.

Sometimes the maintenance engineer himself gets a wrong viewpoint, because he flounders in a mass of detail. He looks at the trees, not the forest. To offset his bewilderment *Maintenance Engineering* provided its Plant Survey Check Sheet with the March issue. By conscientiously using that sheet the maintenance engineer can provide for his own use, and the use of higher executives, a true picture of the plant as it stands today —a picture that will warn against both waste and false economy.

If plants visited by the editors of *Maintenance Engineering* since the check sheet was published are a true cross section, our readers are using the sheet to advantage.

We have a limited overrun that we shall be glad to send without charge to those of our readers who have misplaced or lost their copies.

■

Added Recognition of Centralized Maintenance

ONE FEATURE was stressed in common by the three speakers at a recent Symposium on Maintenance, conducted in Philadelphia by the Philadelphia Section, A.S.M.E. Representatives of a large eastern railroad, a power utility, and a leading rayon manufacturing company emphasized the fact that in their respective companies the recently adopted policy of grouping all maintenance under a single division with centralized responsibility has brought great improvement in maintenance methods and has been, in their opinion, a decided forward step in "preventive engineering."

It is of more than passing significance that this same conclusion should have been reached by engineers in such widely divergent industries. The railroad, with its long operating and development history and far-flung activities, changes procedures only after careful consideration in the light of more than a half-century of engineering experience. The power company, with its demands of non-interruption of service and special equipment problems can afford to pursue only tried-and-proven maintenance policies. And the private enterprise, faced by more pressing competitive problems than the others, must choose methods which give it the greatest operating strength.

The centralized maintenance department, headed by a competent technician—the maintenance engineer—seems to be the answer to at least one operating problem.

■

Weld or Replace?

RECOGNITION of the great possibilities that lie in the application of welding in plant maintenance work is plainly evident in the increasing use of this process. Impressive savings in time, money, and production delays through the ability to make repairs quickly and get machines back into service are now commonplace when welding is properly used.

It is reasonably well understood that in order to produce satisfactory welds good equipment and skilled workmanship are necessary. When these prime requisites are available, assurance of success depends on whether welding of the part in question should be attempted.

It is physically possible to weld almost any iron or steel part. If the work is done with skill and care the weld will be as strong as or stronger than the base metal. Whether the welded part will give satisfactory service will depend, however, on the answer to the question, Why did the part break in the first place? If through accident or abnormal shock the metal was simply overstressed to the point of failure, welding may be used with every prospect of success to repair the break. If failure has come about through fatigue of the metal a different situation is presented.

Under repeated cycles of varying but severe stress breakdown of the crystal structure of the

metal has resulted in a crack. Repairing the break in such parts is likely to lead to disappointment through early failure at some other point, due to weakening of the structure. If failure is not likely to have serious consequences one may be justified in taking a chance and welding the break. In the case of important parts, where failure may endanger life or entail heavy loss, the broken part should be replaced.

■

Plant Housekeeping

VERY properly, "Plant Housekeeping" was a subject for special consideration at the Third Annual Greater New York Safety Conference recently held at New York City. It is but a restatement of the obvious to say that accidents and slovenly plant conditions go hand in hand; but only by constant repetition can general practice be made to conform to accepted principles.

Clean walls and windows; good plant illumination; proper floor surfacing; handy waste receptacles; aisles free of obstructions; properly piled stock; neatly arranged tools and equipment — these are but a few of a category that might be extended almost indefinitely.

Every item mentioned serves to emphasize the fact that a good plant executive must be more than a good technician; all the technical knowledge in the world will avail him nought, as far as plant efficiency is concerned, if he is a poor housekeeper.

■

Homemade or Purchased Equipment?

TODAY, more than ever, is it necessary for the maintenance engineer to gain maximum value for every dollar spent on new equipment or parts. For this reason many engineers have been tempted to build as many as possible of these items within their plants. When considering this possibility the engineer must exercise his best judgment in order to arrive at a sound decision. A method frequently used in making the choice is to compare the purchase price of the equipment with the estimated price of home building.

In underestimating the cost of building, in neglecting adequate consideration of operating and maintenance costs, and in the use of an old purchase price quotation are found three of the common pitfalls that trap the unwary user of this method.

Too late have many engineers found to their dismay that the actual cost of homemade equipment exceeds the estimated price by an amount large enough to make their choice the most expensive. When such equipment never has been built previously in a plant the reason, of course, is that difficulties of design and construction arise that defy prophecy. Although removing "bugs" from machinery is good engineering experience it usually is costly business.

One breakdown of a homemade machine may cost enough to offset any previous price advantage in its favor. Some engineers have decided to build equipment in their plants on the basis of a cost comparison with a purchase price quoted them some time ago, only to find later that the manufacturer's price had dropped enough in the interim to make their decision economically unsound.

■

Running the Job?

RUN THE job, don't let the job run you, we have said. Here is an illustration of what we mean:

Mr. X, plant engineer, saw the need of a new building, planned it, sold it to the management, supervised its erection.

In the new building he installed unit heaters. Everybody liked them, fuel bills were low. "Why not install them all over the plant?" asked the management.

Mr. X reached into his desk, produced calculations showing the heat losses for the entire plant and the estimated savings to be made.

Management marveled, told him to go ahead —only an hour or two required for presentation of data and making of decision. The heaters are being put to work.

Was that running the job? Are we right, or are we right?

■

KNOW much about selecting drives? Can you decide whether to use individual or group drive on a basis of honest-to-goodness cost data?

If you can, you're one of the chosen few. If you can't — well, don't stay in that fix.

Beginning in next month's issue of Maintenance Engineering Robert Drake will give you a series of five articles that will be the last word on Investment and Operating Cost Data for Individual and Group Drives.

PLANT ENGINEERS' FORUM

A new question is presented each month, and our readers' answers to previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

What Human Qualities for Maintenance Men?

Taking advantage of a warm Spring evening, Frank Fulleger and George Shipman and their wives are driving to a nearby town for dinner. Because the men are seated in front and their better halves in the back of the car, conditions are ideal for the men to get in some shop talk. George loses no time in starting the conversation.

* * *

"This weather is more like it, Frank. It's been such a long winter I'd almost forgotten what Spring is like."

"It certainly is a big relief to me to get out in the air again, George, especially after the last few days of grief at the office."

"What now, Frank? I thought you told me business was picking up at your plant the last time I saw you."

"It isn't that, George. Our business is improving. There's been a lot of squabbling and bickering among some of our maintenance and production foremen. The production men say the maintenance men are holding them up unnecessarily, whereas the maintenance men complain that the production men are blocking them in their work at every opportunity. Because both sides tell plausible stories, I haven't been able to put my finger on the guilty persons. It seems to me that they just don't want to get along with each other."

"How long have these foremen been with you, Frank?"

"The production men have been with us for years, but I just hired the two maintenance foremen. The thing that surprised me is that they're darned good men as far as knowing their stuff about the work goes."

"I don't doubt it, Frank. But I think I smell a rat. What kind of personalities have these new maintenance foremen? You know that there's a human side to business and maintenance—a man's ability to get along and cooperate with his associates. Often it's as important a qualification for a man's success as his knowledge and skill. Are these men also sincere, tactful, conscientious, thorough, and loyal? I suspect they don't have all these qualities or you wouldn't be having this friction."

"I believe you've hit the nail on the head, George. But what can I do about it?"

"If they're as good maintenance men as you say, wouldn't it be worth while to give them some instruction on the human side of their jobs? I've had to do it several times in our organization with surprisingly good results. Teach them to see the other fellow's viewpoint."

"Sounds like a good idea. You can bet I'll give it a good trial because I'd hate to let either of the men go. . . . . Your wife is calling you, George. It looks like the end of our session."

* * *

In the hue and cry for increased production and efficiency the human side of business often is forgotten. Readers are invited to send in their discussions of this human side in maintenance work.

How important are human qualities in maintenance work?

What human qualities are essential for a good maintenance man? Which of these qualities are the most important?

Readers' Answers to Previous Questions

Regular Foremen's Meetings?

(Question presented in the April issue)

THE ACTUAL saving resulting from ideas presented at regular meetings of our foremen and department heads in 1931 was $5,700. This sum is a definite figure on which we made a check—it is not an estimate, nor is it based on theoretical savings. We know that time saving devices, changes in routings, and revisions in various methods are responsible for this saving. Naturally, then, we are convinced that such meetings are of considerable value.

The group present at every meeting consists of thirteen key men. In addition, as many as twelve others may be invited, the number depending on how many are concerned with the main theme of the evening's discussion.

All meetings are held after work. The group goes in a body to one of the hotels for dinner. Following the meal they return to the office of the manager where the discussions, lasting exactly two hours, are held. No compensation is paid to persons attending these meetings. The expense of the dinners is borne by the company. Figured on a strictly economical basis the cost of the dinners in order to save the $5,700 was $236.

The first 30 minutes of each meeting are devoted to a brief analysis of the hourly operating cost of each department. Charts showing the rise and fall of costs from one month to the next are shown, along with comparative figures for the preceding three years. Department heads are thus given an opportunity to see how costs in other departments are affected. Although it is true that some question the advisability of making cost figures available in this manner, we believe that a comparison is good for all.

Generally there is no set topic for a meeting. Every person understands that the second Wednesday in each month is devoted to these gatherings, and he generally comes prepared with a few questions. The factory manager conducts the meetings. He always has a few subjects in reserve should there not be enough voluntary questions. The most popular way of getting topics for the meetings is to have every department head turn in two questions in writing the afternoon of the meeting. These questions are brought to the gathering. The questions can be on any topic—personnel, maintenance, manufacturing, or general policies. Most questions concern matters of maintenance and production and, although the manager usually can answer any of these questions, he always asks for opinions from those in attendance.

It is not unusual for one question to be asked early in the evening that alone would take an hour's discussion. As a matter of fact, there never has been a meeting at which all twenty of the questions presented were answered. Questions not answered usually are taken up the next day by the manager with department heads concerned and the person asking the question. It is not unusual for a problem to come up that involves considerable research work.

When the management has a policy or topic that it wishes discussed the subject is announced ahead of time in order to create interest. Usually, however, subjects discussed originate with the foremen and department heads.

A fine feeling of cooperation and friendliness has developed from these gatherings. The department heads speak freely and positively, and there is plenty of friendly bantering, as well as some heated discussions. However, all arguments are closed in a friendly manner before the meeting is over.

C. S. STEVENSON, *Operating Manager*
Hall Brothers, Inc., Kansas City, Mo.

NO DOUBT exists in my mind regarding the value of regular foremen's meetings. In them is offered an opportunity for the interchange of ideas and the smoothing out of inter-departmental differences.

To give a concrete instance, a certain medium-size plant maintains such a weekly meeting plan and it has proved very successful. In the first year of operation this plan was directly responsible for a ten per cent decrease in inter-departmental materials handling costs; an employee's mutual aid society was originated and put on a sound working basis; and minor adjustments were effected through the medium of the informal friendly atmosphere prevailing. The presiding officer at these meetings is the company's employment manager who, after listening to each foreman's report, selects the most pressing subject for discussion. When a ballot is called for on any topic the presiding officer, in the event of a tie, has the deciding vote. Sessions are held during working hours, each foreman's "second in command" being responsible during his absence for the operation of his department.

Among the many subjects discussed, maintenance and its relation to overhead is a prominent topic, and cooperation is stressed as a means to cost reduction.

The success of this experiment in promoting closer intimacy and cooperation between department heads offers convincing proof that this avenue of personnel endeavor is one that no wide-awake organization can afford to neglect.

ROBERT S. ALEXANDER, *Special Department*
Universal Winding Company
Providence, R. I.

FOREMEN'S meetings should be held at regular intervals of not over two weeks. The meetings certainly should be held on company time for, in this way, the foremen are compelled to pick out key men to act in their absence. No foreman is worthy to be called such if he does not study his men and endeavor to develop those that are best qualified to become group leaders. What better opportunity is there for testing these leaders than that afforded when the foreman is not within call?

The meetings should be conducted by the management, but the foremen should put on 90 per cent of the programs. Between 30 and 40 minutes is a long enough time for each meeting. Careful preparation should be

made in advance so that there always is something interesting and worth-while to be presented. Otherwise the meetings are likely to become mere rambling discussions between the fluent talkers.

One method that has been used successfully for breaking the ice at the start is to have each foreman explain the workings and particular problems of his department and how his department is related to other departments. Many misunderstandings are cleaned up in this way.

Recommended subjects for meeting programs are new developments in the manufacturing or maintenance departments and troublesome problems in connection with them. In this way each foreman is given an opportunity to tell of his achievements and, at the same time, another foreman may be taught a method that will enable him to solve one of his problems.

The greatest advantage of these meetings is the engendering of an *esprit de corps,* a desirable attribute in any organization.

E. G. GREEN, *Plant Engineer*
Libbey-Owens-Ford Glass Company
Charleston, W. Va.

ALTHOUGH much can be gained from a meeting of foremen from different parts of a plant or, if necessary, from different plants I believe that twice monthly is far too often to hold such meetings.

Our company has held general get-together meetings at least once a year for several years. As a rule they are held in the Spring and Fall. The time between meetings varies according to the need. At our meetings we invite the sales manager and all of the salesmen.

One hour is not enough for, as Frank said, the foremen were timid at first but at the end they were warming up. For this reason the next thirty minutes of the meeting would have been more valuable to his company than the first hour.

We generally have a banquet after working hours paid for by the company. The reason for including the sales force is that some of them can and will give us some fine pointers on how our competitors' merchandise compares with ours. Frequently they bring samples of products that have caused trouble. If the trouble was caused by poor workmanship the foreman who is responsible for it is informed.

I feel that the executives should manage at least a part of the program of foremen's meetings because they are in direct contact with all departments and are more able to bring out problems of the greatest value to all involved. In short, a company should manage a part and pay for all.

WILLIAM LEE LANGLEY, *Superintendent*
Lipscomb Grain and Seed Company, Inc.
Springfield, Mo.

What Preparation for Recovery?

(Question presented in the March issue)

IT IS A sad fact that many otherwise efficient engineers and executives are prone to confuse economy with parsimony and often go to ridiculous extremes because of this confusion. To illustrate this point, only the other day I read in one of the prominent technical journals that the officials of a certain railroad had issued an order stating that the reserve locomotives in the roundhouse were to be stripped of any part that could be used to keep active locomotives in operation.

I can imagine some of the comments made by non-railroad executives on reading of this situation—yet this same dubious economy is being practiced daily in plants all over the country with, I suppose, the same threadbare alibis offered in justification: "rigid economy," "uncertain business conditions," and "reduced overhead expense." The result is that the plant engineer is left to struggle with a depreciated budget and obsolete equipment, knowing that this shortsighted policy will only react unfavorably by heaping managerial coals of fire on his head when business resumes its normal tenor, power loads are increased, and industry's wheel start to turn in high.

Fortunately, there are concerns that, looking forward to a brighter tomorrow, are overhauling and renewing plant equipment and, consequently, are awaiting the turn of the tide with confident optimism.

In our organization this policy has been in effect since 1930. Building additions have been constructed that afford increased floor space and modern facilities; machinery replacements have been made wherever justified; and maintenance morale has been sustained by steady employment.

As a final argument in favor of preparation for the inevitable business recovery, the buyer's market that we now are enjoying, with equipment and material prices at rock bottom, cannot continue for long, and buying procrastination is bound to be costly.

ROBERT S. ALEXANDER, *Special Department*
Universal Winding Machine Company
Auburn, R. I.

Should Maintenance Methods Be Given Publicity?

(Question presented in the February issue)

THERE are two considerations that should be kept before a manufacturing concern when it is deciding on a policy for publicity.

First, the lower the price at which its product can be sold, the greater will be the amount consumed. All concerns manufacturing a given product are interested equally in this fundamental. Such concerns can and should cooperate in every way possible to bring their sale prices down.

Second, each concern is interested selfishly in making its product better, cheaper, or both than its competitors in order that it may enjoy the maximum possible portion of the business.

It seems to me that in these two statements is the answer as to how much information a company may disclose about its maintenance methods and equipment.

Generally speaking, ordinary maintenance methods can be shared with the effect of bringing down the average cost of a commodity generally to the ultimate advantages of all competing companies. Exchange in ideas between companies in different lines of manufacture is 100 per cent beneficial.

A company best can gain an advantage over its com-

petitors by acquiring a superior manufacturing process, a more efficient method, or better equipment. Such a company should reserve for itself the benefits of any of these advantages.

G. E. LEAVITT, JR., *Plant Engineer*
The Southern Cotton Oil Company
Bayonne, N. J.

GRANTING that an exchange of ideas and methods is always beneficial to all concerned, we should be as willing to disclose our methods and equipment to others as we are to investigate theirs. The day of the "No Visitors" sign is passing, and most plants are proud to exhibit their modern methods and equipment to those who are really interested. Much good already has resulted from the exchange of ideas among manufacturers, and even better results will be obtained as we become better acquainted and cease to look upon our competitors with suspicion. Plant visits are becoming increasingly popular, and numerous trade associations have been organized to promote the exchange of information between their members. Technical publications are doing great work in making known new maintenance methods and illustrating machinery in use in various plants.

Because many companies have special processes that are the result of years of research and the investment of many thousands of dollars it is only reasonable to assume that they should desire to keep them secret. The business of certain companies is based on such processes and to disclose them to competitors would mean the loss of the prestige which they now enjoy. It should be a comparatively simple matter, however, to differentiate between such processes and general factory operations that can be freely disclosed to others.

C. W. SCHWABE
Superintendent Mechanical Department
Mallinckrodt Chemical Works
St. Louis, Mo

THE QUESTION of publicity of plant operations always has been an item of controversy among plant managers and, in some cases, a policy of curtailment has been adopted justifiably. I feel, however, that this limitation should be confined entirely to secret processes and special equipment used only in specific manufacturing institutions. Managers who have spent money and time in developing highly specialized equipment and processes should guard their knowledge carefully to prevent it from falling into the hands of competitors. This policy also should apply to chemical formulas.

Maintenance methods, however, usually are items of such broad and general character that their publicity can in no measure be detrimental to a business. Items relating to boiler and engine room operation; the distribution of heat, light, power, and steam; lubrication; and the maintenance of motors, generators, and other electrical apparatus all pertain to equipment of such standard design and application that the publicity of special ideas on these subjects can in no way harm the plants from which such information emanates.

Plant engineers can gain a great deal more than they give by comparing ideas on specific problems. It is through this interchange of ideas that the breadth of mind of the plant engineer is developed. Wherever it is possible for him to obtain the acquaintance of men in similar positions he can cultivate sources of information that will stand him in good stead when trying problems develop or emergency breakdowns tax his ingenuity to maintain the continuous operation of his plant.

K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company, Brockton, Campello, Mass.

How Valuable Are Professional Plant Surveys?

(Question presented in the January issue)

EVERY time the office boy brings out a person who presents a letter from the purchasing department stating that I shall assist the bearer in a survey of equipment, I experience a feeling of chagrin and a measure of resentment. In such cases my feelings are that I either am falling down on the job or that I have not kept abreast of the times in the maintenance field.

The question of the value of these surveys can be illustrated best by a statement of conditions in two plants each of which received a carbon brush survey.

Electrical maintenance in plant No. 1 is in charge of a practical electrician, who neither has had the benefit of a technical training nor has he availed himself of other sources of knowledge. He has not kept correct records of his equipment. The brush engineer making the survey found out that this electrician was opposed to undercutting his commutators and that he kept his commutators from sparking by a liberal use of sandpaper. Hence all that the brush engineer could recommend for this plant is that it should carry a large stock of abrasive brushes.

Plant No. 2 has a technically trained man at the head of the electrical maintenance department. Following a survey of his motors made by himself he had undercut all commutators. By trial he had discovered that a soft grade of brush gave the best results on all motors except several which operated under unusual conditions. This job was so well done that the management asked why the turnover of brush stock in the storehouse was so small. In this plant a complete record is available of each motor with its correct brush size. When the survey was completed in this plant the only recommendation that could be made was for a few minor changes in brush shunts.

In plant No. 1, had the recommendations of the brush engineer been followed, the savings in brushes and maintenance would have more than justified carrying out the recommendations. But, in plant No. 2, practically the only profit to the plant man was the satisfaction of having his labor approved.

I am of the opinion that in each case the plant owner was receiving something over and above the help that the brush manufacturer usually extended.

In conclusion I believe that surveys should not be forced upon the maintenance man unless he requests them. If he is the right type, he will not need a survey whereas, if he is the other type, he will not heed the recommendations made.

H. E. REINHOLD, *Chief Electrician*
American Sheet & Tin Plate Company, Dover, Pa.

QUESTIONS and ANSWERS

City Gas for Metal Cutting?

I wish that readers would give me some information on the practicability of using ordinary city gas of 550 B.t.u. thermal value in metal cutting torches. (1) Will it be necessary to use oxygen with the gas, or will compressed air be suitable? (2) Under what pressures should the gas and air or oxygen be used? (3) What safety devices, if any, will be required? S.P.C.

Tonawanda, N. Y.

■

Paralleling Generator with Transformers

A 100-kw., three-phase, waterwheel generator normally runs in parallel with a bank of three 100-kw. transformers connected in closed delta to the power company's lines. These transformers are to be overhauled one at a time, while the remaining two transformers are operated in open delta at reduced load. Under these circumstances can the generator be synchronized with the open delta bank without trouble? Will this method of operation cause unbalance in any phase?

Northampton, Mass. **L.G.D.**

■

Using Rotary as Welding Generator

We have a Wagner type BC, model 14T, serial No. 134592, rotary converter rated 1,800 r.p.m., 60 cycles, three-phase, 55 amp. a.c., 70 volts, 50 amp. d.c. Tests have shown that it is good for 150 to 175 amp. continuously without exceeding 40 deg. C. temperature rise. By means of taps on the transformers and brush-shifting, voltages of 50 to 120 can be obtained with good commutation at full load. The voltage recovery is very rapid after a short circuit and the polarity does not reverse. (1) Can this machine be used for light arc welding? (2) What winding should be put on a shell-type laminated core, to be used as a series reactor, all three legs having a cross-section of 3x4½x12 in., with a winding space 1¾ in. deep on the center leg?

Burley, Idaho **V.H.K.**

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

Replace Cables?

At full load the voltage at the terminals of two 40-hp., 220-volt, three-phase motors that drive large drying machines goes down to 195 volts. I presume that the No. 3/0 cable that feeds the motors is too small. We have had no trouble with these motors and I should like to know whether there is any good reason why we should put in larger cables. Would our power bills be affected in any way if larger cables were installed? A.S.

Chicago, Ill.

THE OPERATING voltage of 195 volts is 88.6 per cent of the rated voltage. Motors are guaranteed for continuous operation at a minimum voltage of 90 per cent. Thus, the voltage drop is only 1.4 per cent below the guaranteed voltage.

If the motors are operating satisfactorily and if the cables are not overheating, due to excessive I^2R loss, sufficiently to damage the insulation I can see no reason why the cable size should be changed so far as the motors are concerned.

Tests made at 90 per cent voltage and full load on a 15-hp., 1,750-r.p.m., 220-volt, three-phase, 60-cycle, squirrel-cage motor showed a drop from 92 per cent to 91 per cent in efficiency, an increase from 90.2 to 94.2 per cent in power factor, a drop from 1,743 to 1,729 r.p.m. in speed, and an increase of 15 per cent in current. These data will give an indication of the amount of change in the performance characteristics of such a motor under the conditions cited.

The effect of larger cables on the power bill should be the determining factor in deciding whether to change the cable size. A certain amount of line loss is being paid for in the form of kilowatt-hour energy consumption charges. These losses could be calculated with considerable accuracy. The total I^2R losses should be figured for the present size of cable and the present motor load current, and then figured again for the size of the proposed new cables and the motor load current at the increased voltage. The difference in these two losses would be the savings, representing a return on the investment for the new cables. An indication of the change in motor load current at the increased operating voltage can be obtained from the test values given above. In addition to reducing the kilowatt-hours energy consumption, there would be a very slight reduction in the kilowatt demand, but the savings thus effected would be small.

In referring to line losses I have assumed that the spacing between the cables is such that the reactance drop is low enough to be neglected. If the cables are spaced much more than 3 or 4 in. apart, I would suggest that they be brought closer together so as to reduce the reactance drop. The best arrangement would be to run the cables with no separation, as in a conduit.

General Engineer R. P. GUILDFORD.
Westinghouse Electric & Manufacturing Company, Philadelphia, Pa.

WITHOUT knowing the power factor of the line feeding the two motors in question, it is impossible to figure the loss. From the drop given the power factor is undoubtedly low, or else the line from the transformers is very long. The 3/0 cable has sufficient capacity for the two motors, but if it is rubber covered it is below the size allowed by the Code and should be replaced. Each motor would take, at full load, approximately 100 amp., making the total load 200 amp. For that load the Code calls for 250,000-circ. mil., rubber-covered wire, or No. 3/0 wire with slow-burning insulation.

The power bill would be lowered by installing larger cable, in direct proportion to the percentage decrease in the loss. However, I do not believe that the saving would be great, as I consider the excessive voltage drop to be due more to low power factor than to line resistance. W. L. COTTON.

Dalhart, Tex.

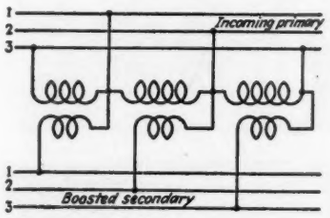
■

Why Shorts and Grounds?

In our plant we have a long secondary transmission line along which there is considerable voltage drop. To overcome this we have installed a set of booster transformers. The line is used to feed several well drills operating on 440 volts, and the operators on the drills use the 440-v. supply to fire their dynamite when clearing a hole. This momentarily puts a short circuit on the 440-v. line. Quite frequently, at the instant that they are firing this dynamite, some part of the portable cables or motors and equipment blows across or shorts to ground. This usually happens on the load side of the booster bank, that is, on some of the equipment opening on the boosted side of the line.

The booster transformers are Allis-Chalmers 5-kva., 440-v. primary, 110-v. secondary, single phase, connected in the line as shown in the diagram.

Do any of the readers see any



connection between the boosters being in the circuit and the trouble with the short circuits and grounds? How can this trouble be overcome?

Stoneco, N. Y. **C.F.S.**

THE SECONDARY line and apparatus are evidently in bad condition, and probably many of the failures occur where one or all of the wires have been spliced. When the line is short circuited arcs may burn away the insulation, and lead to shorts or grounds.

I suggest that all splices be opened and cleaned thoroughly. Place the two ends along side each other and band them together with new No. 26 copper wire. Use a non-corrosive soldering flux and do a good job of soldering. The joints should be taped well with a good grade of rubber tape.

The present method of firing the dynamite puts severe stresses on the line and transformers, as is evidenced by the line failures. The ordinary method of firing charges involves using dry cells and would be much more satisfactory.

If the power line must be used insert in the shooting circuit a resistor of about 10 ohms that will carry 10 amp. continuously. It can be overloaded in view of the very brief period that it is in service. If this arrangement is unsatisfactory, use a lower resistance.

The question indicates that adequate overload protection has not been provided. Suitable fuses or circuit breaker equipment should be installed.

If these suggestions are followed the line maintenance will likely be lowered considerably. If the bad joints are eliminated it may be possible to dispense with the booster transformers.

Pittsburgh, Pa. E. L. BIRD.

■

This Motor Slows Down

A 7½-hp., compound wound, 230-volt, 825-r.p.m. d.c. motor is giving us trouble. This motor drives an embossing paper machine, through a variable-speed transmission in order to vary the speed of the machine from 30 ft. a minute to 250 ft. per min. At about full speed the motor will slow down and almost stop, but the 30-amp. fuse protecting it does not blow and an ammeter put into the circuit shows that the motor is not overloaded. I should like to know what defects to look for and how to remedy them. S.E.G.

Reading, Pa.

THE ANSWER by J. F. Wisinski, published on page 179 of the April issue, does not in my opinion correctly explain the cause of the trouble. It is characteristic of a compound-wound motor to speed up when the series field bucks the shunt field.

The running speed of a d.c. motor is reached when the counter-e.m.f. developed is equal to the impressed or line voltage minus the voltage required to force enough current through the armature to produce the torque required to drive the load. The difference between line voltage and counter-e.m.f. very seldom exceeds 15 volts.

The counter-e.m.f. developed by a motor is determined by the number of lines of force cut per second and the number of conductors cutting them. If the series field is reversed with respect to the shunt field the flux or lines of force created by the series field will counteract an equal number of lines of force created by the shunt field, thereby decreasing the field strength and making it necessary for the armature to run faster in order to develop the required counter-electromotive force.

If the series field neutralizes the shunt field or reduces the field strength so much that the motor does not have enough torque to drive the load there will be an abnormal flow of current and excessive sparking at the commutator. However, the question states that the 30-amp. fuses protecting the motor do not blow and that an ammeter reading shows that the motor is not overloaded.

I suggest that a voltmeter be connected across the brush-holders to ascertain the voltage at various speeds. If there is an appreciable difference in voltage between low speed and high speed the motor will slow down.

The drop may be caused by high line resistance, or if the motor is driven by a small generator the latter may fail to maintain constant voltage. This point should be checked. If there is an appreciable difference between voltmeter readings at the generator and at the motor terminals, the lines are too small or a faulty controller or a loose connection is introducing resistance in the circuit. If the voltage at the generator decreases as the speed of the motor is increased, the fault lies with the generator. If it is a compound-wound generator the series field may be opposing the shunt field, thereby decreasing the voltage as the current increases. Or the prime mover may fail to maintain a constant speed.

Compound-wound motors normally slow down as the load increases, but the difference in speed between no load and full load very seldom exceeds 25 per cent. HOWARD ELY.

Sewaren, N. J.

SLOWING down of the motor is probably due to the starting resistance not being short circuited. If an automatic starter is used it may be found that one of the contactors is not picking up properly.

If the starter is of the manual type the last point of resistance may not be short circuited because the handle is not thrown all the way to the full running position. It is quite possible that this condition may be caused by badly burned contacts.

There may also be a poor contact somewhere in the armature circuit, although this is unlikely as it would probably show itself by marked slowing down and picking up of speed.

Another possibility is that an exceptionally long line of small wire or an improperly connected generator may cause the voltage to be low at the motor, although these conditions would probably be evidenced by trouble with other apparatus.

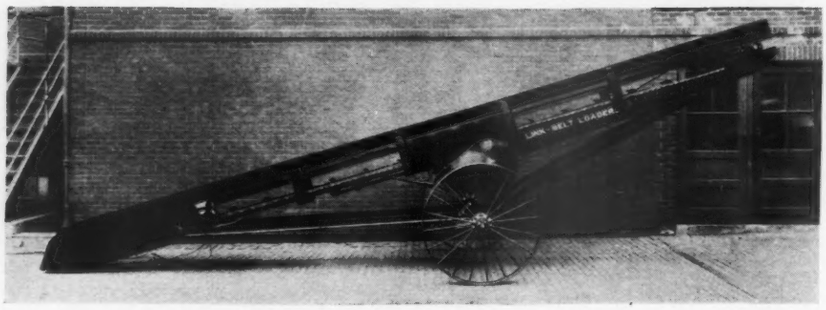
A voltmeter or test lamp placed across the armature brushes will likely show that the voltage drops as the speed is increased.

I therefore suggest that S.E.G. make the same check where the armature leads are connected to the starter. If the voltage still is low go back to where the line leads enter the starter. In this manner it will soon be possible to determine the location of the trouble.

Pittsburgh, Pa. E. L. BIRD.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs



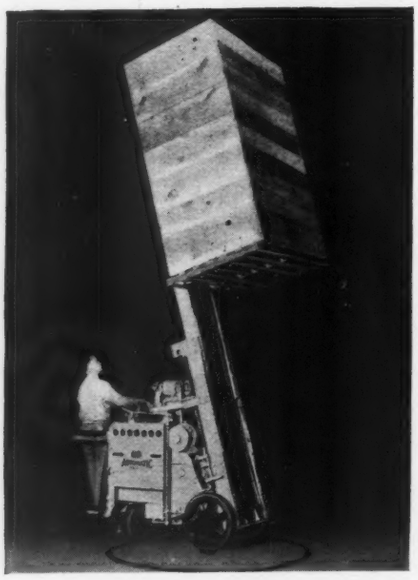
Link-Belt Portable Flight Conveyor

For handling bituminous coal, coke, and other lumpy materials Link-Belt Company, 910 South Michigan Ave., Chicago, Ill., announces a portable flight conveyor, with a capacity of 90. tons of coal per hour with uniform feed for the 26-ft. and 31-ft. sizes, and 60 tons an hour for the 21-ft. size. The corrosion-resisting trough is of copper bearing steel, and the frame of steel angle and channels. Flights are cupped to pick up the material; chain speed is 126 ft. per min. A 5-hp. motor furnishes the drive.

■ ■

Automatic Transportation Fork Truck

For handling materials in factories, shops, terminals, and warehouses, the Automatic Transportation Company, Inc., 101 West 87th St., Chicago, Ill., announces a tilting tiering fork truck. It is available in capacities of 1,000 to 6,000 lb. Telescopic upright members permit a tiering height to be obtained for most operating conditions. Double roller chain lifting mechanism provides elevating speed and safety regardless of load position. The controller is a combination of foot and hand operation. Any standard type of storage battery or self-contained gas-electric power unit may be used in the battery compartment.



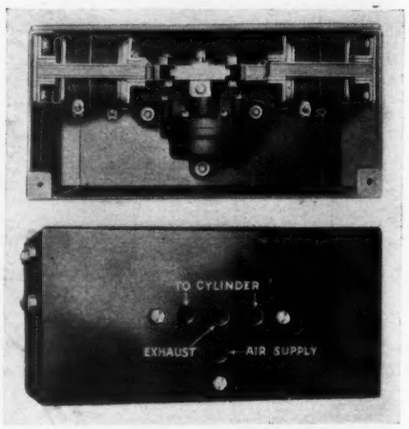
■

Hannifin Electrically Operated Valves

Models C, D, and E electrically operated valves have been announced by the Hannifin Manufacturing Company, Chicago, Illinois.

Model C, furnished in both single and double types, is designed for remote control of either single- or double-acting air cylinders. It is especially applicable to air cylinders used to engage and to disengage clutches on large machinery where it is desirable for the operator to control the starting and stopping of the machine from a number of stations. When the circuit is broken the cylinder is open to exhaust. The valves will operate on 110- or 220-volt, a.c. or d.c. circuits.

Model D is designed for time cycle operation or remote control of an air cylinder. It can be operated manually from a pushbutton station, or automatically with an electrical time cycle unit. Closing the electric circuit causes the pilot valve to admit air to the valve operating cylinder which, in turn, operates the air control valve, thus admitting air to one side of the power air cylinder. Breaking the circuit releases air from the valve operating cylinder which, being a single acting spring return type, reverses the air control valve, thus admitting air to the opposite side of the power air cylinder. This valve unit is designed for operating cylinders of 8-in. bore and larger where the power stroke is to be held for a short period. It can be furnished with a ¼-, ½-, or ¾-in. operating valve. It is furnished for operation on either a.c. or d.c. 110-volt circuits.



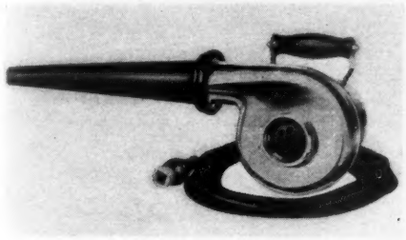
The illustration shows Model E, designed for four-way control of double-acting air cylinders and a wide range of applications. It provides instantaneous pushbutton control of air cylinders from one or more stations and can be used wherever a manually operated valve is now employed. This valve incorporates in its construction the Hannifin "Packless" disk-type design. The valve is operated by means of a double pushbutton switch. Pressing the "start" button operates the cylinder in one direction, and pressing the "stop" button reverses the cylinder. The cylinder is always under air pressure at one

end or the other. The operation of the valve is instantaneous, therefore, only momentary contact of the pushbutton is required. The circuit is closed only when one of the pushbuttons is depressed. The valve also may be arranged for automatic time cycle operation by means of an automatic time switch. The unit is available in two sizes with ¼- or ½-in. connections. It will operate on 110- or 220-volt, a.c. or d.c. circuits.

■

Breuer "Tornado" Blower

A portable electric blower, the "Tornado" Model 4, for blowing dust out of motors and machinery parts, vacuum cleaning bins and stock rooms, and spraying insecticides, has been introduced by the Breuer Electric Manufacturing Company, 852 Blackhawk St., Chicago, Ill. This model is almost identical in design and construction to the large heavy duty line of blowers.



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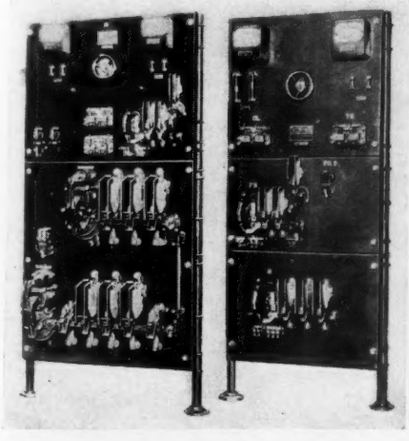
Cutler-Hammer Synchronous Motor Starters

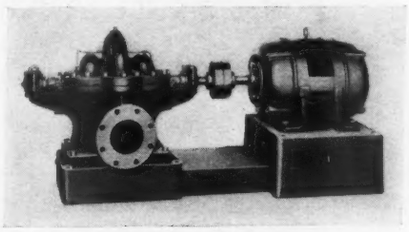
Automatic and semi-automatic starters for synchronous motors are announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. In these new starters a frequency responsive relay functions in connection with an adjustable time delay thermal overload relay. In the case of heavy overload, reduced line voltage, failure of motor field, or loss of d.c. excitation, the frequency relay disconnects the field switch and permits the motor to operate as a squirrel cage motor for a period of about 30 seconds, depending upon the setting of the thermal overload relay. Should normal conditions return within the time adjusted for, the motor will re-synchronize and continue in operation; otherwise it will be disconnected from the line. This frequency relay also controls the field excitation automatically, and on the reduced voltage automatic type it governs the transfer from low starting voltage to full voltages. The starters are made in sizes from 25 to 600 hp. for 220, 440, 550 and 2,200 volts.



■

Fairbanks-Morse Fig. 5803 Centrifugal Pump

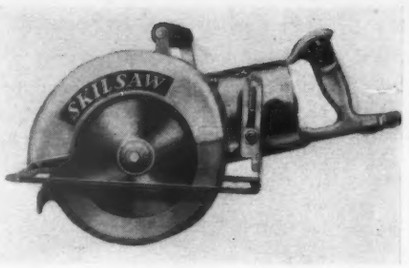
Fairbanks, Morse & Company, 900 South Wabash Ave., Chicago, Ill., announces the Fig. 5803 centrifugal pump, a split-case model. Its streamline construction is reported to result not only in a high built-in efficiency but also to reduce any tendency toward cavitation or pitting. Mechanical features include ball bearings. Cartridge-type bearings make it possible to remove the entire rotating element without disturbing the alignment or introducing dirt or grit into the bearing housings. The casing wearing rings are prevented from rotating with the impeller by a semi-circular locking collar. The same method is used for holding the packing retaining ring in place. Shaft sleeves hold the impeller, which is feather-keyed to the shaft, in a permanent longitudinal position. The shaft sleeves are themselves held in place by hexagonal nuts which serve the additional purposes of water throw rings and bearing pullers. Bases are of the drip-lip type.



■

Skilsaw Electric Hand-Saw

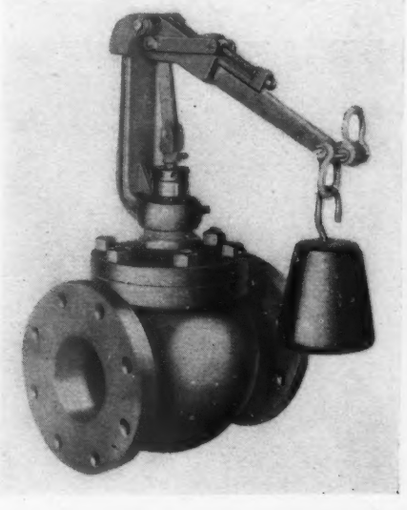
Skilsaw, Inc., 3310 Elston Ave., Chicago, Ill., announces an electric handsaw that measures 20 in. in overall length and weighs 24 lb. It is known as Model S. A ⅞-hp. universal motor is used. The saw has a cutting capacity 3 in. deep and is equipped with a tilting base that permits bevelling 2-in. lumber at a 45-deg. angle. On the base is a metal segment on which the degrees are marked. The base is vertically adjustable for any cutting depth. The saw blade has a free speed of 3,600 r.p.m. and is protected by a positive, automatic-spring-operated telescopic guard rotating on roller bearings. The frame is constructed of die-cast aluminum. All shafts revolve in ball bearings. The upper blade guard is channeled to provide an air passage from the cooling fan on the motor to the contact point of the blade for instant disposal of sawdust on the cutting line.



■

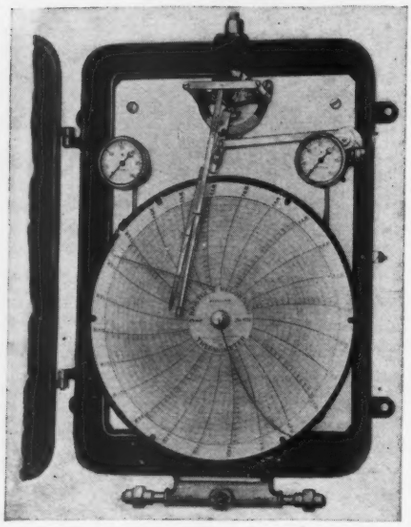
Atlas Lever-Operated Control Valves

For use with any standard control device lever-operated control valves have been announced by the Atlas Valve Company, 282 South St., Newark, N. J. Port openings can be adjusted to suit the load. Valves are fitted with parabolic-type, gradual-opening bevel seats and are capable of being adjusted for minimum flow. No bypass valves are required. Stroke of operating lever at the point where the cable of control mechanism is attached is 10 in. Where other strokes are required, special levers can be furnished. Valves are used where a combination of a damper regulator and a valve for controlling the pressure and flow of gas or liquids is desired. They also are used in combination with floats, direct or pilot operated, for the control of liquid levels.



Bristol Recorder Controller

A three-vane recorder controller, introduced by The Bristol Company, Waterbury, Conn., for controlling and recording pneumatic air systems, em-



ploys a vane floating between two equal air screens, so that the measuring element moves unimpeded as it makes the record. Three vane controllers can be furnished with either vapor, tension, or gas-filled thermometer pistons for use with Bristol 12-in. charts in ranges up to 1,000 deg. F., and with pressure measuring systems up to 1,500 lb. per sq.in. A visible index arm may be set to the reading on the recorder chart at which the temperature or pressure is to be controlled.

■

Acme Floor-Steel

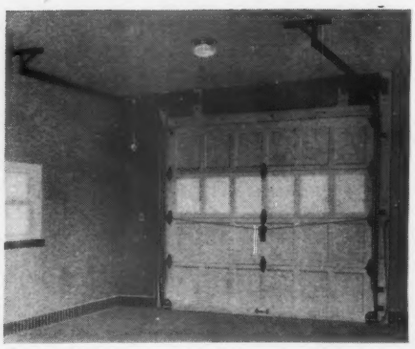
Floor-Steel, announced by the Acme Steel Company, 2840 Archer Ave., Chicago, Ill., is for use in new construction of concrete, hot and asphalt mastic, magnesite, and all other types of poured floors, and for re-surfacing old floors. It may also be used over wood with a suitable filling material. The flooring

is manufactured in cold rolled strips and is furnished in rolls containing approximately 100 sq.ft. After the strips are unrolled upon the floor base, they are joined into a mat, continuous in all directions, by a system of pin connections and wire splices. Filling material is poured over it, and the floor is leveled off flush, leaving the top edges of the steel exposed in the surface to take the wear.

■

Barber-Colman "Barcol Overdoor"

Barber-Colman Company, Rockford, Ill., announces the Model 50 "Barcol Overdoor." It is an upward-acting, sectional, overhead-type door. The vertical track has a short sloping section near the floor to carry the bottom roller only, and the other rollers are moved into position by swinging hinge plates. All hardware is supplied in natural finish. A ball bearing roller is used. Stock door sizes are 8x7 ft., 8x7½ ft., 8x8 ft., and 8x10 ft. Bolt strikes that can be adjusted to meet any changes in the floor level are used on the locking device. Special doors can be supplied

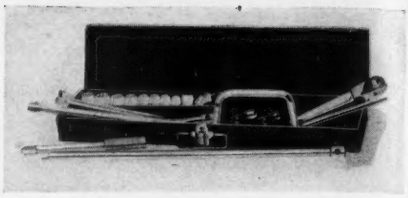


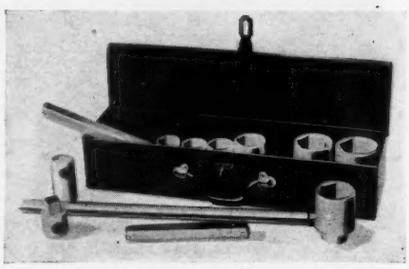
when required, and accessories are available to meet special conditions. Metal or metal-covered doors also can be made on special order.

■

Bonney Wrench Sets

Additions to its line of wrench sets, announced by the Bonney Forge and Tool Works, Allentown, Pa., consist of an extra-heavy duty socket series of 14 hexagon sockets, in sizes from 1 7/16 in. to 2¾ in. with 9- and 18-in. extensions, and a 22-in. sliding bar, (upper illustration); a No. XH heavy duty socket set of seven hexagon sockets in 1 7/16-in. to 2⅜-in. sizes with a 22-in. sliding and an 18-in. extension bar, all contained in a metal carrying case 23x5½x4½ in., of 42 lb. total weight; a small series set TD2, for aviation and automotive work, of eight double-hexagon sockets in 7/16-in. to ¾-in. sizes, an offset handle,





universal joint, 12-in. extension "T" handle, drag link socket, and two crowfoot box attachments, all in a metal carry case (lower illustration); and a No. 4086, chrome vanadium steel offset handle, of 10-in. overall length with a 3-in. offset.

■

American Meters

A rotary condensation meter in two sizes, one 250-lb. capacity per hour, and the other 500-lb. per hour, is now being made by the American District Steam Co., North Tonawanda, N. Y. This instrument is a bucket type meter containing six identical buckets locked in position of the rotor axis. As the buckets are filled the weight of the con-

densate causes rotation, discharging the buckets and bringing empty buckets successively into position for filling. The rotary motion is transmitted to the dial which registers the measurement in pounds.

■

Service "Textolite" Casters

Caster wheels for factory trucks made of "Textolite," a material consisting of woven duck impregnated with a phenolic resin, have been announced by the Service Truck & Caster

Company, Albion, Mich. After being impregnated this material is hydraulically molded under high pressure and great heat. It is reported to have about the same strength as semi-steel. Characteristics claimed for the casters

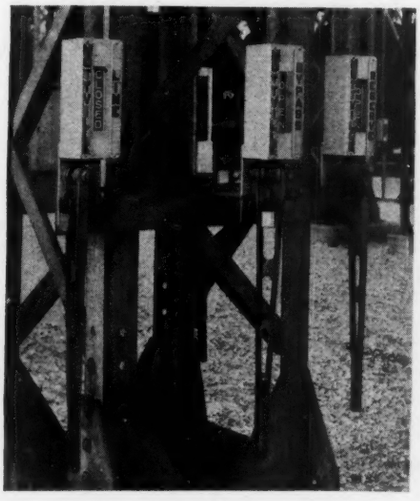
are that they are elastic, resilient, quiet, and light and that they are not affected harmfully by grease, oil, water, brine, or mild acids.

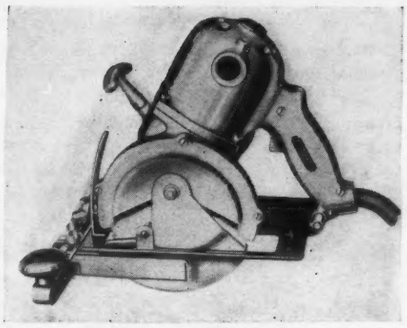
Casters are available in diameters ranging from 3¼ to 12 in. and are made with or without ball or roller bearings, according to the service required.

■

Delta-Star Switch Position Designators

Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., announces a line of weather-, water-, and oil-proof designator signs for attachment to switch mechanisms, identifying poles, transmission towers, cell identificators, oil switch and transformer numbering, and operating instructions. Pressed zinc frames hold movable bakelite letters which can be changed to meet local conditions. A typical installation is pictured of air break, switch-operating mechanisms equipped with the designators.





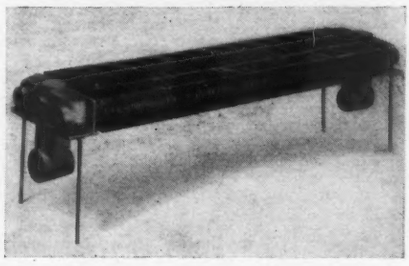
Stanley Electric Safety Saw

A light weight electric hand saw for ripping flooring, and for making packing cases, crates, and the like is announced by the Stanley Electric Tool Company, New Britain, Conn. An auxiliary handle, ripping gage, and 12½ ft. of cable are included in the set.

■

Commodore "Convectofin" Built-In Heater

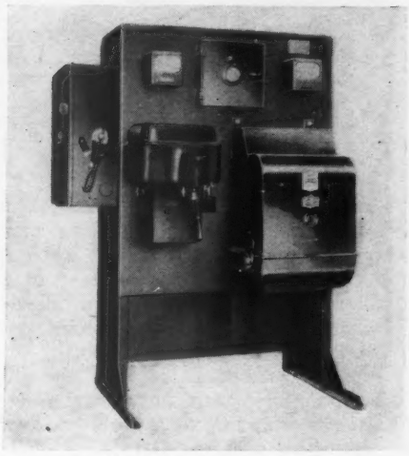
Commodore Heaters Corporation, 11 West 42nd St., New York, N. Y., announces a built-in heater called "Convectofin" because it operates on the convection heating principle and because of the copper fins on its heating element. The unit is placed inside of a furniture steel cabinet, the front panel of which has air inlet and outlet grilles. Many combinations and designs of cabinets and heating elements are available; they may be placed under the window, in the waste space of the wall, or they may be concealed behind the plaster finish. The heater operates like a chimney. The hot fins heat the air in the cabinet, and a draft is created that draws the cooler air from the floor level.



■

Cutler-Hammer A.C. Fire Pump Starter

A manually operated a.c. fire pump motor starter, approved by the Underwriters Laboratories as an inclosed controller, has been announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. The complete controller includes a single- or double-throw disconnect switch, an oil circuit breaker, an auto-transformer type starter, an ammeter and voltmeter, a pilot light, and control-circuit fuses. The auto-transformer starter gives one step of reduced voltage starting. The various control, indicating, and protective units are mounted on a "dead-front" steel panel type floor frame. The wiring between the various units is fully inclosed in the rear of the frame. All parts are accessible to facilitate periodic inspection. Line and motor terminals are located near the bottom of the frame where they are convenient to the floor conduit. The starters are made in sizes up to 150 hp. at 550 volts.



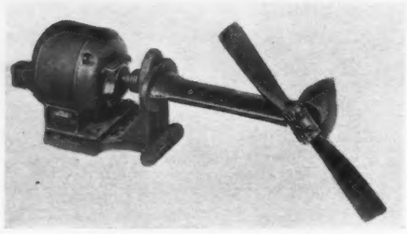
■

Clark Lifting and Tiering Truck

A lifting and tiering truck for loads with 2-in. under-clearance is announced by the Clark Tructractor Company, Battle Creek, Mich. Loads are carried on tapered steel fingers with a standard length of 26 in. which touch the floor in down position. It is provided with four-wheel steer and rear wheel drive. The 2-ton model, gas-powered for continuous operation, has a turning radius of 89 in.; the 3-ton, a radius of 98 in. The trucks employ hydraulic lifts, and transit speeds of from 1 to 6 m.p.h. can be attained. All trucks are rubber tired.

Vallen "Ventilaire" Fan

Volume and velocity of blown or exhausted air can be varied to compensate for differences in operating conditions by adjusting the pitch of the blades of the "Ventilaire" fan, announced by the



Vallen Electrical Company, Inc., Akron, Ohio. The fan was designed especially for duct installations. A high efficiency is claimed for the unit because of its streamlining and lack of an internal mounting ring. Each blade is designed to eliminate a dead-center spot by providing a pronounced curve at the axis, and a slight forward curve at the blade tip is incorporated to prevent back currents or air pockets. Blades are geared to the motor through an extended arm containing a right-angle geared speed reducer. Necessary support for the motor may be had by mounting its aluminum base on the wall, ceiling, or floor, or by suspending it from supports attached to the duct system. The motor is connected to the extended shaft by a flexible coupling. Motor bearings are wool packed, and ball bearings are used in the fan. The line is available in standard sizes for ducts 12 to 20 in. in diameter.

■

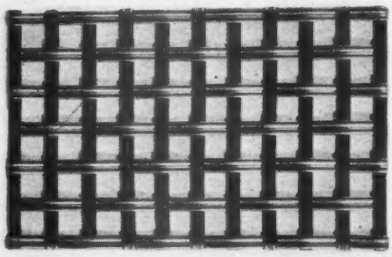
Dudley Combination Locks

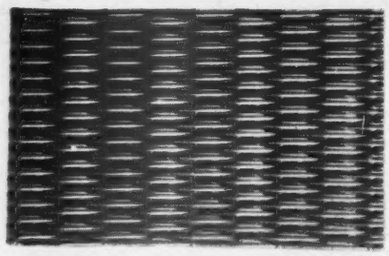
Dudley Lock Corporation, 26 North Franklin St., Chicago, Ill., announces two combination locks, the "Rotodial" and the "Rotopoint." The principle of operation of the two locks is practically identical, the difference between the two being mainly in materials and appearance. Not only do they lock automatically upon closing, but also the locks disguise all clues to the combination at the same time, without the necessity of turning the knob or dial. Each lock has 216,000 different possible combinations.

■

Loometal Grilles

Loometal Products, 125 Walnut St., Watertown, Mass., announces a line of metal grilles, known as Loometal, for such applications as baskets, elevator cabs, fire screens, metal chairs, partitions, radiator inclosures, screen doors, and ventilators. Three weave designs are available. Weave No. S5, shown at the bottom in the illustration, is especially suitable for use where circulation of air without visibility is sought. Weave No. S7, shown at the top in the illustration,



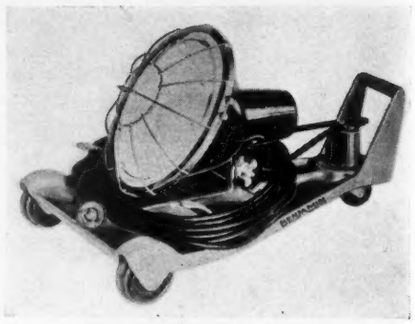


is particularly adaptable for application wherever ventilation and decorative efforts are desired. For applications in which a light gage of metal is sufficient and a large amount of free area is desired, Weave No. SR8 is recommended.

■

Benjamin "Mobilite"

Benjamin Electric Manufacturing Company, Des Plaines, Ill., has placed on the market the "Mobilite," an enamel floodlight mounted on a three-wheeled truck. For maintenance and repair work in industrial plants and railroad car shops the units provide adequate light in hard-to-get-at places. For automobile repairing the unit can be rolled under the car. It facilitates work in unlighted greasing pits, under



hydraulic lifts, and is especially useful in changing tires at night. The porcelain enamel, adjustable reflector is equipped with a clear cover glass and a guard.

The wheeled truck is pivoted at the rear and is provided with fiber, insulating rollers. Two sizes are available with 100- and 200-watt lamps.

■

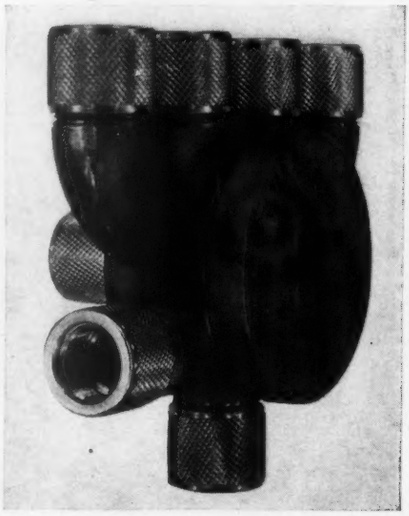
Medusa Floor Coating

A floor coating, announced by the Medusa Products Company, a subsidiary of the Medusa Portland Cement Company, 1002 Engineers Bldg., Cleveland, Ohio, contains a special pigment reported to be three times harder than steel. This pigment provides resistance against normal abrasion and wear on concrete and wood floors. Only one coat is required over previously painted surfaces. The paint is manufactured in the following colors: light gray, dark gray, tile red, brown, and black.

■

Pyle-National Conduit Fittings

Explosion resisting, screw covered junction boxes with universal hubs, for gasoline pumps and similar hazardous location wiring, are announced by the Pyle-National Company, 1334 North Kostner Avenue, Chicago, Ill. The Type YT 104 junction box (illus-



trated) has a cast iron body with internally threaded, overlapping brass covers. The line also includes circuit breakers, switch fittings, conduit unions, and light control switch fittings.

■

Kennedy Standard Gate Valve

The Kennedy Valve Manufacturing Company, Elmira, N. Y., announces a standard bronze, solid-wedge, stationary-stem gate valve for 125-lb. per sq.in. steam pressure and 175-lb. per sq.in. water pressure. The stuffing box is provided with a gland on all sizes.

Packing rings are of molded square section and are made of a composition material which has a high graphite content. The weights of all sizes meet Government specifications.

■

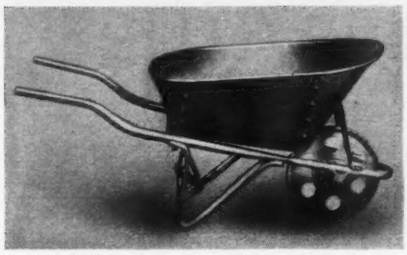
Linde Bronze Welding Rod

Bronze welding rod known as "Oxweld" No. 25M, said to be non-fuming, has been introduced by The Linde Air Products Company, 30 East 42d St., New York, N. Y. Welds made with it have consistently shown a hardness of 96 Brinell. The bar is supplied in $\frac{1}{8}$-, $\frac{3}{16}$-, and $\frac{1}{4}$-in. sizes.

■

Cleveland Aluminum Wheelbarrow

A light weight wheelbarrow, entirely of aluminum with the exception of the axle, and weighing 37 lb., is being manufactured by the Cleveland Wheelbarrow & Manufacturing Company, Cleveland, Ohio. The tray is of 40-gage aluminum sheeting, handles are of tubing, and the braces are aluminum channel sections. The wheel has roller



bearings. Overall dimensions are 60 in. long by 24 in. wide, by 29 in. high. Capacity is 3 cu.ft. of wet concrete or 4 to 5 cu.ft of sand.

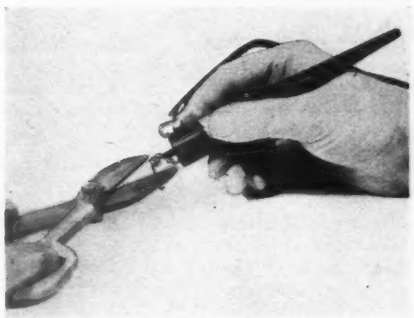
■

Stibloy Now Produced and Distributed by New Koppers-Control Company

The Stibloy Products Company, Inc., with principal offices in the Koppers Building, Pittsburgh, Pa., has taken over the assets of Liquid Metal Products, Inc., Chicago, producers and distributors, under the Arent patent, of Stibloy—a liquid metal compound for primary coatings to hold paint, enamel, and lacquer.

Martindale Metal-Marker

Articles made of iron or steel can be marked by the metal-marker announced by The Martindale Electric Company, 1260 West 4th St., Cleveland, Ohio. The instrument is operated like a pencil. In operation, the writing point is raised and lowered rapidly by an electromagnet. The writing, therefore, consists of a series of small dots. Although the marker operates best on iron and steel it can be used on brass, copper, aluminum, and other current-conducting metals. The device is furnished complete with a six-voltage transformer, a writing pen, writing points, ground terminal, ground plate, spring clips, and connecting wires.



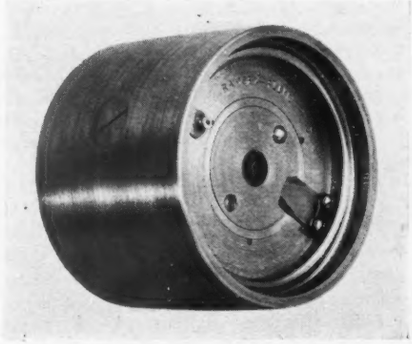
■ ■

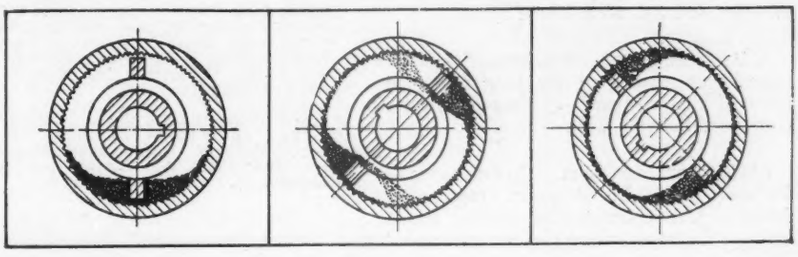
Ramsey-Pulvis Clutch

Ramsey Chain Company, Albany, N. Y., announces that it has obtained exclusive rights to manufacture and sell the Ramsey-Pulvis clutch in the United States. The device is an automatic starting clutch that employs centrifugal force to permit the driving motor, or other prime mover, to come up to speed without load and to protect the driving motor against overload shocks. It is available as a pulley clutch for use with flat belts, as a coupling, and in the silent-chain, sheave, and gear types.

The three sketches illustrate the operation of the clutch. The winged rotor is the driving element and the serrated roll is the driven member. Small hardened steel balls constitute the power transmitting medium. They are graphite coated for atmospheric protection and lubrication. At the start of the rotor the balls are rotated or shoveled through orifices in the rotor wings, and the shell remains, for the moment, at rest. As the motor speeds up the centrifugal force increases and, when the rotor reaches top speed, the balls are thrown against the serrated surface of the shell with such force that they interlock and form a solid mass. The tightly packed shot now has assumed a definite position in front of each wing and, therefore, the shell revolves with the rotor.

Starting characteristics and driving power can be varied in each clutch by changing the quantity of shot.





TRADE LITERATURE

For copies, address the manufacturers concerned

■

(131) CIRCUIT BREAKERS — Bulletin C-1939, "De-ion" circuit breaker for low voltages. — Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(132) SHEET STEEL—Booklet, 12 pages, Armco electrical sheet steel grades.—The American Rolling Mill Company, Middletown, Ohio.

(133) BELT CONVEYORS—Catalog 535, 48 pages. Design, construction and installation details on Jeffrey belt conveyors.—The Jeffrey Manufacturing Company, Columbus, Ohio.

(134) MATERIALS HANDLING — Bulletin, 32 pages, "Push-Pull-Haul-Hoist with McCormick-Deering Industrial Power."—International Harvester Company of America, Incorporated, 606 South Michigan Ave., Chicago, Ill.

(135) STRUCTURAL PANELS—Bulletin F-10, 18 pages, "Ferroclad" structural panels, —Truscon Steel Company, Youngstown, Ohio.

(136) POWER TRANSMISSION — Folder, Lewellen variable speed transmission.—The Lewellen Manufacturing Company, Columbus, Ohio.

(137) POWER TRANSMISSION — Bulletin 501, 4 pages, single and double row radial thrust roller bearings. Complete dimensions and list prices, with speed factor table for figuring intermittent speeds.—Shafer Bearing Corporation, 621 South Kolmar Ave., Chicago, Ill.

(138) STATIONARY DIESEL ENGINES — Bulletin S-500-B5A, 8 pages, 4-cycle direct-injection type, 50-150 hp.; Bulletin S-500-S5, 6 pages, 150-300 hp.; Bulletin S-500-B7, 12 pages, 225-450 hp.; Bulletin S-500-S4, 6 pages, 300-600 hp.; Bulletin S-500-S6, 6 pages, 375-1,000 hp. sizes.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(139) SWITCHES—Leaflet GEA-19G, CR7006-D7B and -D7F, magnetic switches for a.c. motors.—General Electric Company, Schenectady, N. Y.

(140) HEATERS—Bulletin 4, 4 pages, "Convection Takes the Place of Radiators."—Commodore Heaters Corporation, 11 West 42d St., New York, N. Y.

(141) ELECTRICAL PRODUCTS—Folder, 8 pages, photographs of the new Bellwood plant of this company.—Jefferson Electric Company, Bellwood, Ill.

(142) PORTABLE AIR COMPRESSORS — Bulletin W-850-B5, 4 pages, mechanical features and mountings on trailer, truck, tractor, railroad car, mine car and wood skids.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(143) AIR CONDITIONING—Armco architectural bulletin No. 8, 8 pages, "How Conditioned Air Was Provided for the New Louisiana Capitol."—The American Rolling Mill Company, Middletown, Ohio.

(144) MOTORS — Folder GEA-1580, 4 pages, type KE, single-speed induction motors for elevator service. — General Electric Company, Schenectady, N. Y.

(145) INSTRUMENTS — Catalog 40, 32 pages, "Apparatus for Electric Resistance Measurements."—Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

(146) LATHES—Booklet "How to Run a Lathe," 30th edition, a manual on machine shop work in general and on the care and operation of a modern screw-cutting engine lathe in particular.—South Bend Lathe Works, 426 East Madison St., South Bend, Ind.

(147) CHAINS—Catalog V-100, 76 pages, silent chains and sprockets for power transmission.—The Whitney Manufacturing Company, Hartford, Conn.

(148) INSTRUMENTS — Catalog 401, 24 pages, "Free Vane, Air Operated Recorder Controller."—The Bristol Company, Waterbury, Conn.

(149) LIGHTNING PROTECTION—Booklet No. 1 of a series of 10 on lightning protection, "Facts About the Crystal Valve."—Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(150) CENTRIFUGAL PUMPS — Bulletin W-321-S1A, "Monobloc" type (centrifugal pumps bolted to motor frame with impeller mounted on motor shaft), cross section views, rating tables and pump combinations with motor characteristics.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(151) AIR CONDITIONING — Catalog No. 388, "Air Conditioning for Railway Passenger Cars."—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(152) SWITCHES—Leaflet GEA-1588, CR7006, explosion-proof, magnetic-switches. —General Electric Company, Schenectady, N. Y.

(153) LAMINATED PHENOLIC MATERIALS —Folder, 4 pages, engineering design folder on laminated phenolic products, technical data and general information of value to users of these materials.—Spaulding Fibre Company, Tonawanda, N. Y.

(154) FLEXIBLE COUPLINGS—Catalog 11, 20 pages, construction and installation features, illustrations and data on all the types and sizes in the line.—Diamond Chain and Manufacturing Company, Indianapolis, Ind.

(155) VERTICAL GAS ENGINES—Bulletin S-550-S1, 6 pages, 4-cycle vertical gas engines, 60-180 hp. sizes.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(156) CONTROL—Bulletin, "Monitor Accelerator" for starting d.c. motors.—Monitor Controller Company, Baltimore, Md.

(157) TOOLS—Catalog 387, 8 pages, portable and stationary vacuum cleaner tools and attachments.—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(158) CAPACITOR MOTORS — Bulletin, theory and advantages of the capacitor type motor together with a discussion of an oil condenser unit especially applicable to this class of service.—Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York, N. Y.

(159) REFRIGERATION — Catalog R-4, 12 pages, "Mercoid" refrigeration controls.—The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.

(160) REVERSING SWITCHES—Leaflet GEA-1565, CR7009, magnetic reversing switches for a.c. motors.—General Electric Company, Schenectady, N. Y.

COMING EVENTS

American Foundrymen's Association—36th Annual Convention, Hotel Statler, Detroit, Mich., May 2-5, 1932. G. E. Hoit, Manager American Foundrymen's Association Inc., 222 W. Adams St., Chicago, Ill.

3-M Congress, Featuring Management, Maintenance, and Materials Handling —Under the auspices of Management and Materials Handling Divisions of the American Society of Mechanical Engineers. Hotel Statler, Detroit, Mich., May 4-5, 1932.

National Fire Protection Association—36th annual meeting, Atlantic City, May 9-12, 1932. Association headquarters, 60 Batterymarch St., Boston, Mass.

American Gear Manufacturers Association—16th Annual Meeting, Cleveland, Ohio, May 12-13, 1932. Secretary T. W. Owen, 3608 Euclid Ave., Cleveland, Ohio.

Association of Iron and Steel Electrical Engineers — Exposition and Convention, William Penn Hotel, Pittsburgh, Pa., June 20 to 23, 1932. Managing Director, John F. Kelly, Empire Building, Pittsburgh, Pa.

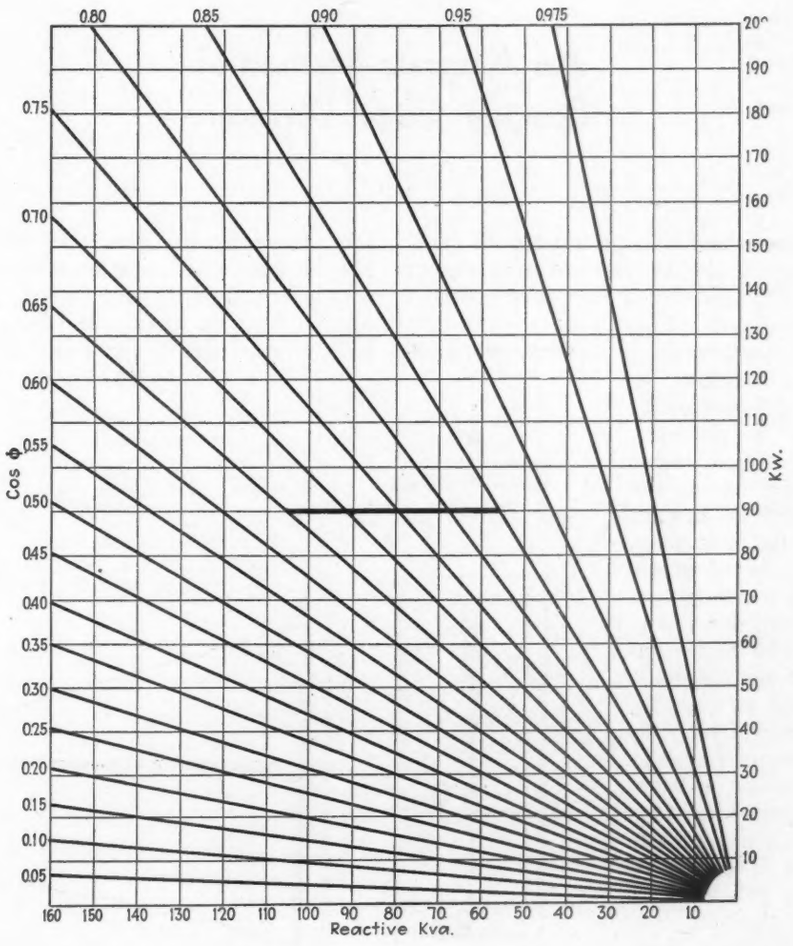
American Society for Testing Materials —Annual Meeting, Atlantic City, N. J., June 20 to 24. Assistant Secretary, R. E. Hess, 1315 Spruce St., Philadelphia, Pa.

Illuminating Engineering Society—26th Annual Convention, New Ocean House, Swampscott, Mass., during the week of Sept. 26th, 1932. Assistant Secretary, Frank G. Horton, 29 West 39th St., New York, N. Y.

Sixth Chicago Power Show—Coliseum, Chicago, June 25 to 30, 1933. Managers, Midwest Engineering Exposition, Inc., 308 W. Washington St., Chicago, Ill.

MAINTENANCE ENGINEERING'S DATA SHEETS

Corrective Capacity for Raising Power Factor



THE KVA. required to raise power factor to a desired value—the required condenser capacity—may be determined quickly by the use of the chart.

Procedure: On the perpendicular axis on the right side of the chart, mark the point which corresponds to the average load in kw. From there move to the left, and the distance between the two points on the horizontal scale at the bottom, where the horizontal line cuts the rays of the present and desired power factor, indicates the number of idle kw. or the required kva. capacity of the condenser for the desired power factor.

Example:

Average load = 90 kw.
Present power factor = 0.65
Desired power factor = 0.85

It will be seen from the chart that the length of the line drawn between the cos ϕ rays of 0.65 and 0.85 is 50 kva. on the horizontal scale at the bottom; therefore, a plant with a load of 90 kw. will require a condenser with a reactive capacity of 50 kva. to increase the power factor as desired.

Courtesy, Emile Haefely & Company, Ltd.

Gages for Horizontal Storage Tanks

An Accurate Method of Spacing Gage Divisions

IN ONE plant where a large number of horizontal storage tanks of various sizes are in use, all large tanks are fitted with float-operated gages. These consist (Fig. 1) of a sheet-steel float 12 in. in diameter by 2 in. deep, connected to a cast iron indicator by galvanized-steel flexible wire cord, $\frac{1}{16}$ in. in diameter, running over a sash pulley mounted on the top of the gage, and over an upright iron pulley on the tank cover. The indicator is a square frame, having a pointer extending out from one side to the middle. The frame has a vertical rib on the back, along both ends, to space the indicator away from the figures painted on the gage. The gage may be a board having two galvanized-steel ropes or wires $\frac{1}{8}$ in. in diameter stretched at each side. These may be held in place by means of threaded eyebolts passed through holes in a short length of angle-iron attached across the top and bottom of the board. The guide wires are spaced to conform with holes drilled through the indicator frame, and to hold the indicator just clear of the board. Preferably, however, the gage may be of a strip of No. 18 gage steel, bent in the form of channel, with a section of the side flanges, $\frac{3}{4}$ in. wide, bent over in front to retain the indicator in the channel. A good size to make the indicator is about

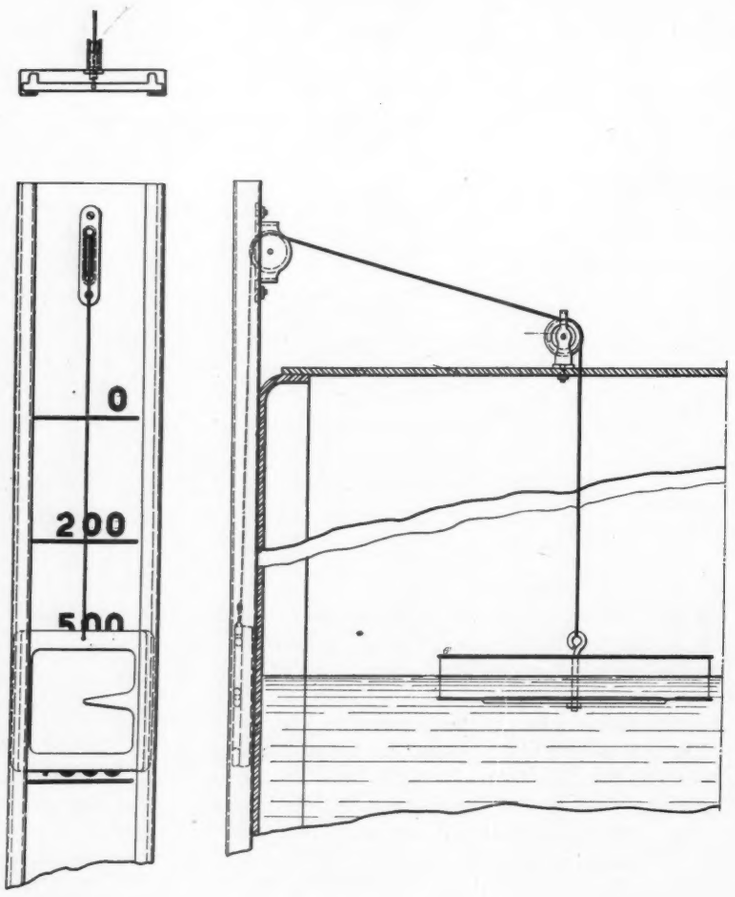


Fig. 1—Float-operated gage for a horizontal storage tank.

Submitted by Earl E. Porter, Mechanical Engineer
The Arco Manufacturing Company, Cleveland, Ohio

(Continued on the following page)

Gages for Horizontal Storage Tanks

(Continued from the preceding page)

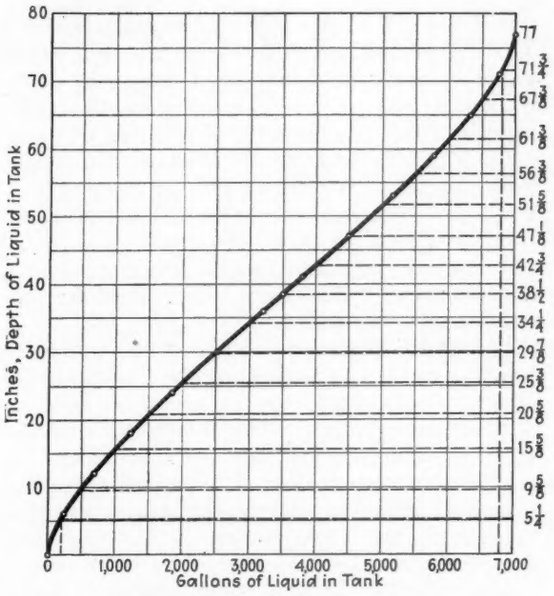


Fig. 2—Gallons of liquid versus inches depth of liquid for a 7,000-gal. car tank 77-in. diameter, 28 ft., 3 in. long, with dished heads.

6-in. square, weighing 2 or 3 lb. A sheet of lead of about the same weight should be soldered to the bottom of the float to insure even working.

In order that the quantity of material in the tank may be readily estimated when the gage indicator points to an intermediate position between numbered marks on the gage, it is desirable that these marks be numbered in decimal quantities, as in hundreds or thousands of gallons or barrels.

A table of coefficients of areas of circular segments is required, such as is found in the Carnegie Steel Company's "Pocket Companion" for engineers and builders, which gives coefficients for ratios of rise and diameter. For the present purpose it is only necessary to use enough computations of volumes at different depths in order to be able to construct a smooth curve of gallons versus depth. Increments of depth of approximately one-tenth or one-twelfth the diameter of the tank will be sufficient. For instance, for a 4-ft. diameter tank a ratio for each 4 in., and for a 20-ft. diameter tank, ratios for each 2 ft. would be used.

Referring to the accompanying table for a 7,000 gal. car tank having an average diameter of 77 in., and length of 28 ft. 3 in. (neglecting the dished heads), the areas of the end-segments for each 6 in. of depth to the middle are computed by the table of coefficients, or ratios of rise (depth) to diameter. To obtain the numbers

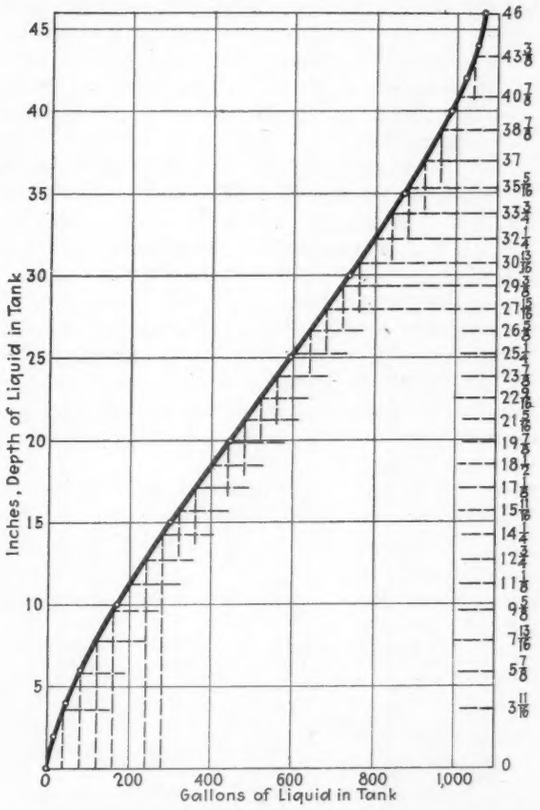


Fig. 3—Chart for converting the Standard Oil Company's gage table for horizontal tanks 46 in. in diameter by 148 in. long, 1,065 gal. capacity, into even tens of gallons.

in the second column, *b* over *d*, which is the ratio of depth to diameter, the depths in the first column are divided by 77. In the handbook are found the coefficients corresponding to these ratios, and these are placed in the third column. In the example shown, four decimal places are used, and the coefficient obtained closer by interpolation. The area of each segment (fourth column) is obtained by multiplying the diameter, 77, squared, which is 5,929, by the coefficient.

The average length for each segment (fifth column) is the estimated length due to the heads

(Continued on the following page)

Gages for Horizontal Storage Tanks

(Conclusion)

being dished. For a tank with flat heads, this would simply be the inside length. The sixth column is the product of each area multiplied by its length in inches; and this volume in cubic inches, divided by 231, gives the gallons total capacity for each depth. The last column gives the number of gallons in each successive six-inch layer, the sum of which serves as a check on the figures. This column is obtained by subtracting each quantity from the one below it in the seventh column, up to the mid-point of the tank, then setting the same figures in reverse order from the middle, 38½ in. Starting at 3,500 in the seventh column, the differences, just below the last column, are added to each successive volume, and points for the entire curve are thus determined.

But the computations are rather impractical in their present form, for they give the gallons only for each six-inches of depth, in odd figures, making it difficult to arrive at a quick and accurate estimate of the quantity shown by the gage indicator. For instance, if there were 57 in. of liquid in the tank, the gage would point to two-thirds the space between 53 in. and 59 in., indicating a quantity two-thirds of the way between 5,770 and 5,150 gallons. Two-thirds of 620 is 413. which, added to 5,150, gives 5,563 gallons. This is much harder to guess than a quantity two-thirds of the way between 5,000 and 6,000, which would instantly be placed at 5,666 gallons.

To get the proper spacing for decimal divisions on the gage, a curve (Fig. 2) is plotted as shown, with volumes in gallons as abscissa and inches depth of liquid as ordinate. A smooth and symmetrical curve should be drawn, even though by doing so some points may be missed, since their displacement will be due to slight errors of computation. From this curve the number of inches from the zero line (top mark on the gage) at which the various desired volumetric divisions are to be made, can be readily obtained.

A line may be painted across the gage at each division mark. Just above these lines the gallonage may be stencilled.

The second chart (Fig. 3) is an illustration of this easy method of converting the Standard Oil Company's gage table for horizontal tanks 46 in. in diameter by 148 in. long, 1,065 gal. capacity, which the company supplies with its tanks, into a table for a gage reading in even tens of gallons instead of inches or gallons per inch, where it is desired to take close readings. In such cases it is important that the tanks be set level.

TABLE OF CAPACITIES OF HORIZONTAL TANK 77 IN. IN DIAM. BY 28 FT. 3 IN. LONG
(NEGLECTING DISHED HEADS)

See Table II, Areas of Circular Segments, for Ratios of Rise and Diameter: Carnegie Steel Company's "Pocket Companion".

b = Depth. Area = d × Coefficient. d = 77 in. (d^2 = 5,929 sq.in.)

Depth (b) Inches	Ratio b/d	Coefficient	Area Sq.In.	Av. Length in In.	Volume Cu.In.	Volume Gallons	Difference (Gal. per 6 In.)
0						0	
							248
6	.0779	.02829	167.7	341.8	57,300	248	
							439
12	.1558	.07805	462.5	342.3	158,300	687	
							543
18	.2337	.1395	827.0	343.5	284,000	1,230	
							620
24	.3117	.2089	1,237.0	344.8	427,000	1,850	
							660
30	.3895	.2831	1,680.0	345.6	581,000	2,510	
							700
36	.4675	.3602	2,135.0	347.0	742,000	3,210	
							290
38.5	.5	.3927	2,328.0	347.0	807,000	3,500	
							290
41						3,790	
							700
47						4,490	
							660
53						5,150	
							620
59						5,770	
							543
65						6,313	
							439
71						6,752	
							248
77						7,000	